D 71683

elektor

up-to-date electronics for lab and leisure

94

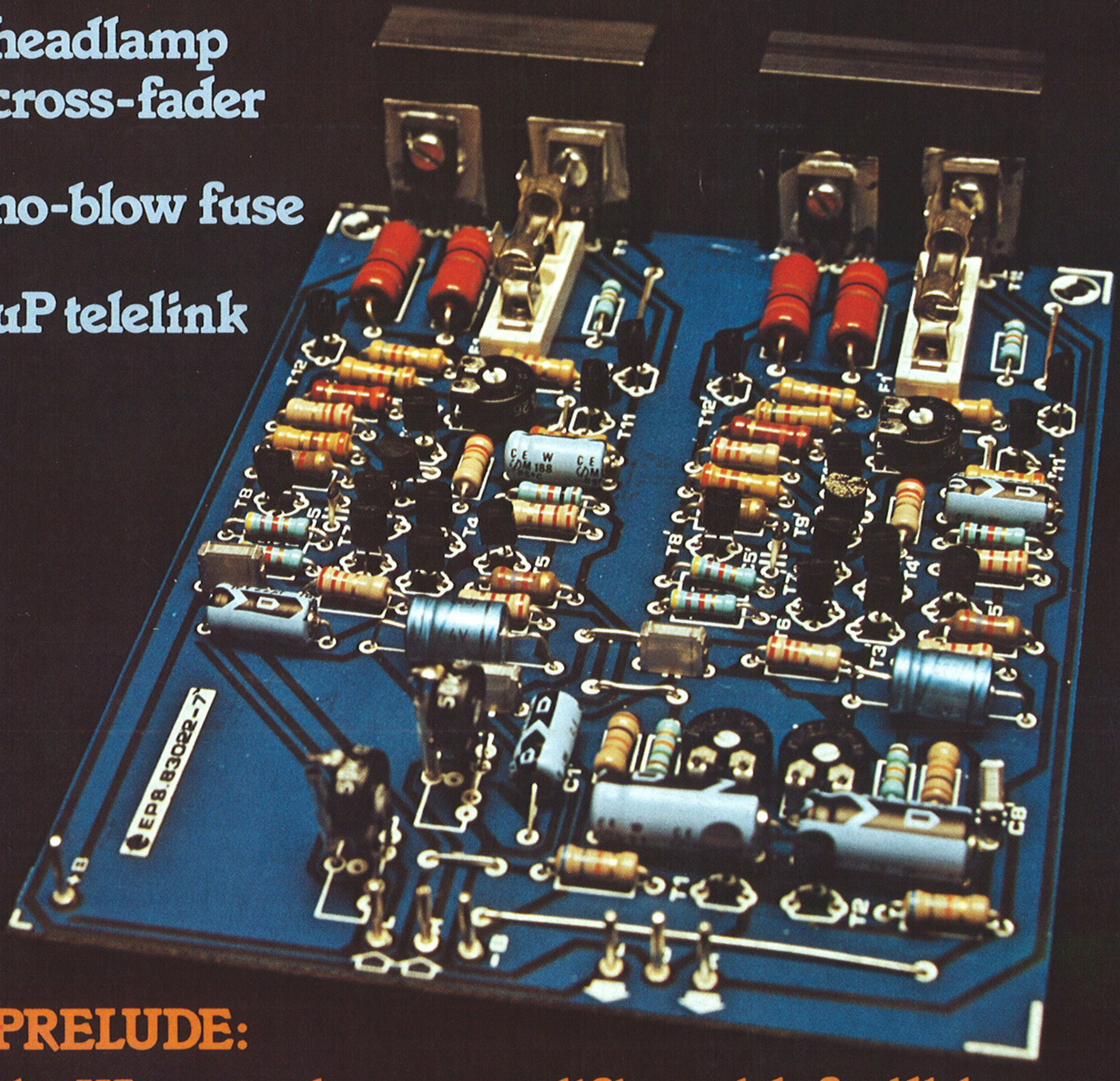
February 1983

75 p.
IR 112 p. (incl. VAT)
$ 2.50

headlamp cross-fader

no-blow fuse

µP telelink



PRELUDE:

the XL control pre-amplifier with facilities:
class-A headphone amp * bus board based *
remote control option * etc

TTLs

7400	11p
7401	11p
7402	11p
7403	12p
7404	12p
7405	15p
7406	18p
7407	18p
7408	14p
7409	14p
7410	14p
7411	16p
7412	14p
7413	16p
7414	18p
7416	18p
7417	18p
7420	14p
7421	18p
7422	20p
7423	18p
7425	18p
7426	18p
7427	18p
7428	18p
7430	14p
7432	18p
7433	22p
7437	22p
7438	22p
7439	25p
7440	15p
7441	55p
7442A	30p
7443	70p
7444	70p
7445	50p
7446A	50p
7447A	36p
7448	45p
7450	15p
7451	15p
7453	15p
7454	15p
7460	15p
7470	30p
7472	25p
7473	25p
7474	18p
7475	22p
7476	25p
7480	48p
7481	120p
7482	65p
7483A	38p
7484	65p
7485	60p
7486	18p
7489	170p
7490A	20p
7491	35p
7492A	25p
7493A	24p
7494	35p
7495A	35p
7496	35p
7497	90p
74100	80p
74104	50p
74105	55p
74107	22p
74109	25p
74110	30p
74111	55p
74112	170p
74116	50p
74118	55p
74119	60p
74120	60p
74121	25p
74122	30p
74123	36p
74125	30p
74126	30p
74128	36p
74132	30p
74136	28p
74141	55p
74142	175p
74143	200p
74144	200p
74145	40p
74147	75p
74148	60p
74150	50p
74151A	36p
74153	36p
74154	50p
74155	40p
74156	36p
74157	30p
74159	75p
74160	40p
74161	40p
74162	40p
74163	40p
74164	45p
74165	45p
74166	48p
74167	150p
74170	120p
74172	250p
74173	50p
74174	55p
74175	50p
74176	40p
74177	45p
74178	70p
74180	40p
74181	115p
74182	40p
74184	90p
74185A	90p
74186	470p
74188	250p
74190	45p
74191	45p
74192	45p
74193	45p
74194	40p
74195	40p
74196	40p
74197	40p
74198	80p
74199	80p
74221	55p
74251	45p
74259	100p
74265	45p
74278	140p
74279	40p
74283	50p
74284	160p
74285	160p
74290	75p
74293	80p
74298	100p
74365A	30p
74366A	30p
74367A	30p
74368A	30p
74390	75p
74393	90p
74490	95p

74LS SERIES

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74LS04	12p
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74LS09	12p
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74LS11	13p
74LS12	13p
74LS13	20p
74LS14	25p
74LS15	12p
74LS20	13p
74LS21	13p
74LS27	13p
74LS30	13p
74LS32	13p
74LS33	14p
74LS37	14p
74LS38	14p
74LS42	30p
74LS47	36p
74LS51	14p
74LS55	15p
74LS73	18p
74LS74	16p
74LS75	18p
74LS76	18p
74LS83	38p
74LS85	40p
74LS86	16p
74LS90	22p
74LS92	30p
74LS93	22p
74LS96	50p
74LS107	20p
74LS109	27p
74LS112	20p
74LS113	20p
74LS114	22p
74LS122	25p
74LS123	34p
74LS124	90p
74LS125A	24p
74LS126A	25p
74LS132	34p
74LS133	25p
74LS136	25p
74LS138	27p
74LS139	27p
74LS145	70p
74LS147	100p
74LS148	75p
74LS151	40p
74LS153	40p
74LS154	80p
74LS155	30p
74LS156	36p
74LS157	27p
74LS158	30p
74LS160A	36p
74LS161A	36p
74LS162A	36p
74LS163A	36p
74LS164	40p
74LS165A	50p
74LS166A	60p
74LS170	70p
74LS173A	55p
74LS174	40p
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74LS191	36p
74LS192	36p
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74LS299	180p
74LS323	160p
74LS324	150p
74LS348	90p
74LS352	60p
74LS353	60p
74LS363	140p
74LS364	140p
74LS365A	30p
74LS367A	30p
74LS368A	30p
74LS373	55p
74LS374	55p
74LS375	45p
74LS377	70p
74LS378	70p
74LS390	45p
74LS393	45p
74LS399	160p
74LS445	100p
74LS540	90p
74LS541	80p
74LS610	£19
74LS640	100p
74LS641	100p
74LS642	100p
74LS643	100p
74LS644	100p
74LS668	100p
74LS669	100p
74LS670	120p
74LS682	300p
74LS684	300p
74LS687	£400p

74C SERIES

74C244	160p
74C245	180p
74C373	160p
74C374	160p

4000 CMOS

4000	10p
4001	10p
4002	12p
4006	50p
4007	14p
4008	36p
4009	24p
4010	24p
4011	11p
4012	16p
4013	20p
4014	48p
4015	40p
4016	20p
4017	32p
4018	45p
4019	25p
4020	48p
4021	40p
4022	45p
4023	13p
4024	32p
4025	13p
4026	80p
4027	20p
4028	40p
4029	45p
4030	15p
4031	125p
4033	125p
4034	140p
4035	45p
4036	275p
4037	110p
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4039	290p
4040	40p
4041	40p
4042	40p
4043	40p
4044	40p
4045	105p
4046	50p
4047	45p
4048	50p
4049	24p
4050	24p
4051	45p
4052	60p
4053	50p
4054	90p
4055	90p
4056	90p
4059	450p
4060	55p
4063	90p
4066	27p
4067	225p
4068	14p
4069	14p
4070	14p
4071	14p
4072	14p
4073	14p
4075	14p
4076	48p
4077	16p
4081	14p
4082	15p
4086	40p
4089	125p
4093	24p
4094	90p
4095	75p
4096	70p
4097	290p
4098	90p
4099	100p
40100	200p
40101	130p
40102	140p
40103	170p
40104	90p
40105	110p
40106	36p
40107	60p
40108	450p
40109	100p
40110	275p
40114	225p
40244	160p
40245	180p
40257	160p
4502	60p
4503	45p
4507	35p
4508	130p
4510	45p
4511	45p
4512	48p
4514	110p
4515	110p
4516	55p
4518	40p
4519	30p
4520	50p
4521	90p
4526	60p
4527	60p
4528	50p
4531	125p
4532	70p
4534	400p
4536	270p
4538	90p
4539	70p
4541	70p
4543	75p
4553	245p
4555	35p
4556	35p
4557	300p
4560	120p
4566	160p
4568	250p
4569	170p
4572	30p
4583	90p
4584	36p
4585	75p
4599	290p
4724	150p
40014	40p
40085	90p
40097	45p
14411	675p
14412	800p
14433	1100p
14495	300p
14500	575p
14599	290p
CD22100	350p
CD22101	700p
CD22102	700p

COUNTERS

74C925	400p
74C928	600p
ICM7216B	2000p
ICM7217A	850p
MK50398N	750p
ZN1040E	670p

TTL & ECL

10116	70p
10231	350p

LINEAR I.Cs

AY1-0212	600p	MF10CN	250p
AY1-5050	99p	MK50398	750p
AY3-8910	380p	MK50Z40	£9
AY3-8912	625p	ML920	800p
AY5-4007D	600p	MM57160	620p
CA3019	80p	NE531	140p
CA3028A	120p	NE555	16p
CA3046	70p	NE556	45p
CA3080E	70p	NE564	420p
CA3086	48p	NE565	120p
CA3089E	200p	NE566	155p
CA3090AQ	375p	NE567	140p
CA3130E	90p	NE571	400p
CA3140E	40p	NE5534A	250p
CA3160E	100p	RC4136	60p
CA3161E	150p	RC4151	200p
CA3162E	450p	S566B	225p
CA3189E	300p	SAA1900	£16
DAC1408-8	200p	SAD1024A	900p
HA1388	250p	SFF96364	800p
ICL7106	700p	SL490	350p
ICL8038	300p	SN76477	450p
LF351	48p	SP8515	750p
LF356P	95p	TA7205	90p
LM10C	325p	TAA550	50p
LM301A	25p	TAA621	275p
LM310	120p	TBA641BX1	400p
LM311	70p	TBA800	80p
LM318	150p	TBA810	100p
LM319	215p	TBA820	80p
LM324	30p	TBA950	225p
LM339	50p	TC9109	750p
LM348	65p	TCA210	350p
LM358P	60p	TCA220	350p
LM377	175p	TCA440	220p
LM380	75p	TCA940	175p
LM381AN	180p	TDA1004A	300p
LM386	90p	TDA1008	320p
LM387	120p	TDA1010	200p
LM389	95p	TDA1022	500p
LM393	100p	TDA1024	120p
LM394CH	300p	TDA1034B	250p
LM709	36p	TDA1170	300p
LM710	50p	TDA2002V	300p
LM711	70p	TDA2020	320p
LM733	60p	TLO71/81	25p
LM741	18p	TLO72/82	45p
LM747	70p	TLO74	100p
LM748	35p	TLO83	75p
LM1886	700p	TLO84	90p
LM1889	350p	TLO94	200p
LM2917	200p	TL170	50p
LM3900	50p	TMS1601	£12
LM3909	85p	UAA170	170p
LM3911	125p	ULN2003	108p
LM3914	200p	XR2206	300p
LM3915	200p	ZN414	80p
LM3916	225p	ZN419C	190p
LM13600	110p	ZN424E	130p
MB3712	200p	ZN425E	340p
MC1310P	150p	ZN426E	300p
MC1458	36p	ZN427E	590p
MC1495L	350p	ZN428E	400p
MC1496	70p	ZN1034E	200p
MC3340P	120p	ZN1040E	670p
MC3401	50p	ZNA234	850p
MC3403	65p	ZNA134	£23

VOLTAGE REGULATORS
Fixed Plastic TO-220

1A	+ve		−ve	
5v	7805	40p	7905	45p
6v	7806	40p	7906	45p
8v	7808	40p	7908	45p
12v	7812	40p	7912	45p
15v	7815	40p	7915	45p
18v	7818	40p	7918	45p
24v	7824	40p	7924	45p
100mA +ve			TO-92	
5v	78L05	30p	79L05	50p
12v	78L12	30p	79L12	50p
15v	78L15	50p	79L15	50p

OTHER REGULATORS

LM309K	140p		
LM317T	200p	78MGT2C	140p
LM323K	450p	79GUIC	225p
LM723	30p	79HGKC	650p
78GUIC	200p	78PO5	900p
78HO5	550p	RC4195NB	150p
78HGKC	600p	TL494	300p

OPTO-ELECTRONICS

2N5777	40p	ORP60	120p
OCP71	250p	ORP61	120p
ORP12	90p	TIL78	55p
TIL32	55p		

OPTO-ISOLATORS

ILD74	130p	TIL111	70p
MCT6	160p	TIL112	70p
MOC3020	150p	TIL 113	70p
MSC2400	190p	TIL116	70p

LEDS

0.125″		0.2″	
TIL220 Red	10p	TIL209 Red	10p
TIL222 Gr	12p	TIL212 Ye	15p
TIL228 Ye	15p	TIL211 Gr	12p
Rectangular		LEDS (R, G, Y)	30p

DISPLAYS

DL 704	140p	NSB5881	570p
DL 707 Red	140p	TIL311	600p
DL 707 Gr	140p	TIL312/3	110p
DL 747 Red	225p	TIL321/2	130p
DL 747 Gr	225p	TIL330	140p
FND357	120p	7750/60	200p
FND500	90p	BARGRAPH	225p
FND507	90p	**DRIVERS**	
MAN3640	200p	9368	250p
MAN4640	200p	9370	300p
MAN6610	200p	UDN6118	320p
		UDN6184	320p

★ SPECIAL OFFER ★

2114L	80p	4116–2	80p
2716 (+5V)	250p	4164–2	450p
2532	350p	6116P–3	350p

TRANSISTORS

BC107/8	14p	BC548C	9p	MJ2955	90p	2N2219A	25p
BC108/9	15p	BC549C	12p	MJ3001	225p	2N2222A	25p
BC109/C	16p	BC557B	12p	MJE2955	130p	2N2484	25p
BC140	30p	BC558B	12p	MJE3055	70p	2N2646	45p
BC141	30p	BC559C	16p	MPF102	30p	2N2905A	25p
BC160	30p	BCY71/2	20p	MPF103/4	30p	2N3053	25p
BC161	30p	BD131	60p	MPF105	30p	2N3054	55p
BC177	16p	BD132	40p	MPSA12	30p	2N3055	35p
BC179C	18p	BD135	40p	TIP29C	40p	2N3442	140p
BC182/L	10p	BD136	35p	TIP31B	40p	2N3702/3	10p
BC183/L	10p	BD139	40p	TIP31C	50p	2N3704/5	10p
BC184/L	10p	BD241B	75p	TIP32A/C	75p	2N3773	200p
BC212/L	12p	BD242B	75p	TIP32C	50p	2N3819	20p
BC213/L	11p	BF244B	25p	TIP33C	70p	2N3820	40p
BC214/L	10p	BF256B	45p	TIP35C	150p	2N3866	90p
BC327	10p	BF257/8	30p	TiP36C	160p	2N3904/6	15p
BC337	10p	BF259	35p	TIP41C	55p	2N4871	50p
BC338	15p	BF337	30p	TIP42A	50p	2N5245	40p
BC477	30p	BFR80/81	25p	TIP42C	60p	2N5457/8	30p
BC516/7	36p	BFY50/51	24p	TIP47	90p	2N5459	30p
BC547B	12p	BFY52	24p	TIP54	160p	2N6027	30p
		BFY90	75p	TIP2955	60p	3N128	120p
		MJ2501	225p	TIP3055	60p	3N140/1	120p
				2N2160	295p	40673	75p
						40871/2	100p

Transistors for all Elektor projects stocked.

DIODES

BY127	12p
OA47	9p
OA90	9p
OA91	9p
OA95	9p
OA200	9p
OA202	10p
IN914	4p
IN4148	4p
IN4001/2	5p
IN4003/4	5p
IN4006/7	7p
IN5401/3	14p
IN5404/7	19p
IS920	9p

BRIDGES

1A50V	19p
1A100V	20p
1A600V	30p
2A50V	30p
2A100V	35p
2A400V	45p
3A200V	60p
4A100V	95p
4A400V	100p
6A50V	80p
6A100V	100p
6A400V	120p
8A100V	150p
10A100V	180p
10A400V	200p

SCRS

1A 50V	70p
5A 400V	50p
8A 600V	140p
16A100V	200p
C106D	45p
MCR101	36p
T1C44	36p
2N3525	130p
2N4444	140p
2N5060/4	40p

ZENERS

2.7V-33V	
400MW	9p
1W	15p

TRIACS

Plastic	
3A 400V	60p
6A 400V	70p
6A 500V	90p
8A 400V	75p
8A 500V	95p
12A500V	105p
16A500V	130p
T 2800D	130p
T1206D	50p
T1226D	70p

RAMS

4116L-20	80p

PCB MOUNTING DIL RELAYS

6vDC 100R coil
SPDT 2A 24v DC
120v AC **£1.60**

12v DC 400R coil
SPDT 2A 24v DC
120v AC **£1.60**

12v DC
270R coil
SPDT 10A 24v DC
230v AC **£2.25**

12v DC
200R coil
DPDT 5A 24v DC
230v AC **£2.25**

DIL REED RELAYS

5-10v DC coil
0·5A SPDT **£2.25**

CPU's

1802CE	650p
2650A	1200p
6502	350p
6800	225p
6802	250p
6809	650p
INS8060	1100p
8080A	250p
8085A	450p
8088	£18
Z80	290p
Z80A	320p
Z80B	£12
TMS995	£12

SUPPORT DEVICES

3242	800p
6522	310p
6532	550p
6551	650p
6821	100p
6850	110p
6852	250p
8205	225p
8212	110p
8216	100p
8224	200p
8228	220p
8251	250p
8253	390p
8255	250p
8257	400p
8259	400p
8271	£36
8279	440p
Z80P10	250p
Z80AP10	280p
Z80CTC	250p
Z80SIO 1/2/3	£9

MEMORIES

2101-4L	400p
2102-2L	120p
2107B	500p
2111-4L	300p
2112	300p
2114L	90p
2114L-2	95p
2147	400p
4027	300p
4116L-2	90p
4118	400p
4164	400p
4816AP-3	280p
5101L	300p
6116P-3	420p
6116LP-3	550p
6514	200p
6810	120p

PROMS

71301	700p
74S188	275p
74S201	350p
74S287	350p
74S387	350p
74S470	600p
74S471	600p
74S571	650p
74S573	900p
82S123	300p
82S137	750p
93427	400p
93436	650p
93446	650p
93448	900p

BAUD RATE GENERATOR

COM8116	700p
MC14411	675p

EPROMS

2516	250p
2564	£12
2708	250p
2716	250p
2532	375p
2732	450p
2716 300nS	500p
2732 300nS	750p
2764	£11

MODULATORS

6MHz UHF	375p
8MHz UHF	450p

UARTS

AY-5-1013P	300p
AY-5-1015P	300p
IM6402	450p
TR1602	300p
COM 8017	300p

CRT CONTROLLER

CRT 5027	£18
CRT 5037	£18
CRT 6545	900p
MC6845	650p
MC6847	£10
SFF96364	£8
9365	£48
EF9366	£48
TMS9927	£18
TMS9928	£20
TMS9929	£20

CHARACTER GEN.

RO-3-2513U.C.	750p
RO-3-2513L.C.	700p
SN74S262AN	£10

CRYSTALS

100KHz	250p
200KHz	280p
1MHz	290p
1.008MHz	275p
1.843MHz	210p
1.89MHz	300p
2.0MHz	225p
2.457MHz	210p
3.276MHz	150p
3.57945MHz	100p
4.0MHz	150p
4.19MHz	200p
4.43MHz	110p
5.068MHz	200p
6.0MHz	150p
7.0MHz	150p
8.0MHz	175p
8.867MHz	175p
10.7MHz	150p
15.0MHz	200p
18MHz	200p
24.00 MHz	200p
26.690MHz	150p
27.145MHz	200p

KEYBOARD ENCODER

AY-5-2376	700p
74C 922N	420p

TELETEXT DECODER

SAA5020	£6
SAA5030	£9
SAA5041	£16
SAA5050	£9
EF9340	700p
EF9341	700p

INTERFACE ICS

AD558	775p
AD561J	£20
DM8131	275p
DP8304	250p
DS8835	200p
DS8836	150p
DS8838	225p
MC1488	55p
MC1489	55p
MC3446	300p
MC3480	850p
MC3486	500p
MC3487	300p
75107	90p
75110	90p
75150P	120p
75154	140p
75182	90p
75324	375p
75361	150p
75363	150p
75365	150p
75451/2	72p
75491/2	65p
8T26	120p
8T28	120p
8T95/96	90p
8T97/98	90p
9601	220p
9602	220p
9637AP	160p
ZN425E-8	350p
ZN426E-8	350p
ZN427E-8	600p
ZN428E-8	500p

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	9p	18 pin	16p	24 pin	24p
14 pin	10p	20 pin	18p	28 pin	26p
16 pin	11p	22 pin	22p	40 pin	30p

WIRE WRAP SOCKETS BY TEXAS

8 pin	30p	18 pin	50p	24 pin	70p
14 pin	35p	20 pin	60p	28 pin	80p
16 pin	40p	22 pin	65p	40 pin	100p

JUMPER LEADS

24″ Ribbon cable with DIP Headers

	14 pin	16 pin	24 pin	40 pin
Single End	145p	165p	240p	380p
Double End	210p	230p	345p	540p

24″ Ribbon cable with sockets

	20 pin	26 pin	34 pin	40 pin
Single End	160p	210p	270p	340p
Double End	290p	385p	490p	540p

24″ Ribbon cable with edge conn.

	20 way	34 way	40 way	50 way
Single End	275p	525p	600p	650p

24″ Cable with 25 way D Connector
Male 500p Female 540p

EURO CONNECTORS

	Plug	Socket
DIN 41612 2 × 32-way	300p	350p
angled 2 × 32-way	350p	400p
angled 3 × 32-way	400p	—
(for 2 × 32 way specify a + b or a + c)		
DIN 41617 31-way	200p	200p

IDC CONNECTORS

	10 way	20 way	26 way	34 way	40 way
Header Plug	90p	150p	200p	240p	270p
Receptacle	90p	165p	200p	240p	270p
Edge Conn.	200p	250p	320p	380p	560p

MIN. D CONNECTORS

	9 way	15 way	25 way	37 way
MALE				
solder	95p	135p	200p	280p
angled	160p	230p	265p	425p
FEMALE				
solder	125p	190p	245p	375p
angled	175p	240p	310p	500p
hood (top/side entry)	100p	100p	100p	150p

25 way Centronix Type Conn. £6.50
37 way Centronix Type conn. £6.50

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2.5″ × 3.75″	80p

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Reprint of Teletext articles **£1.25** (plus large SAE)

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2716 Tape Management	**£8**	71301 Elekterminal	**£7**
2716 Prog. Management	**£8**	2716 Disco Lights	**£8**
82S23 Interface	**£5**	82S23 Freq. Counter (IC 3C4)	ea **£5**
2716 Housekeeper	**£8**	2716 Talking Dice	**£8**

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contents

selektor 2-16

Prelude part 1 2-18
The preamplifier of the Elektor XL system. A completely modular design allowing the constructor to configure it according to the facilities required. The Prelude handles, controls, and distributes varying signal sources, and it is also suitable for equipping with a cordless remote control.

VAM – video/audio modulator 2-27
The growth in the number of video enthusiasts has kept pace with that of computer 'freaks'. The colour modulator presented here is driven from the RGB output of a personal computer, thereby keeping everyone happy.

main beam dimmer 2-32
Every motorist has been dazzled by oncoming vehicles that fail to dip their headlights, and the results can be dangerous. The culprit also has a problem. If he suddenly dips his lights then his sight is affected by the new situation. An electronic solution has now been found: dimming/dipping in stages with the main beam dimmer.

Prelude class A headphone amplifier 2-34
In keeping with the XL system this article introduces an amplifier which delivers in class A a useful 160 mW per channel into 8 Ω. It can be used separately or with any other control amplifier even though it was originally intended as a part of the XL Prelude.

fuse protector 2-39
Where circuit breakers are utilised in place of mains fuses, it is quite common for a variety of high powered appliances, when switched on, to cause them to trip. One way to get over this problem is by using a fuse protector.

acoustic telephone modem 2-42
A circuit designed to send and receive digital information via normal telephone lines. It enables the interconnection of two computers (or terminals) even though they are physically separated by large distances. The modem is compatible with an RS 232 interface and is acoustically coupled requiring no modification to your existing telephone receiver.

double dice 2-51
Here we go; a non talking double dice, which, if nothing else, is self explanatory. It is not totally dumb however, showing the score on LED displays as either a single or a double dice.

chips for digital audio part II 2-54
In last month's article the source such as the compact disc was discussed in great detail. This time we discuss the distinct possibility that 'Hi-Fi' systems of the future will look more like microcomputers, and rather than talking about signal-to-noise ratio, we will mention software and so on.

applicator 2-58
A good look at programmable universal filters with switched capacitors.

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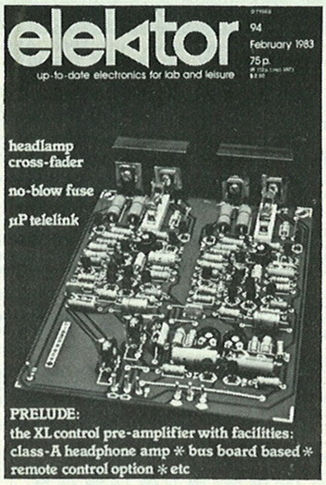
elektor
94
February 1983
75p
up-to-date electronics for lab and leisure
headlamp cross-fader
no-blow fuse
µP telelink
PRELUDE:
the XL control pre-amplifier with facilities:
class-A headphone amp * bus board based *
remote control option * etc

Over the next few months, we will be dedicating quite a few pages to the description of 'Prelude'. Several of the modules used in this preamplifier are useful circuits in their own right: this month's headphone amplifier is an example.

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ELECTROLYTIC CAPACITORS: (Values in uF) **500v**: 10uF **52p**; 47 **78p**; 63V: 0.47, 1.0, 1.5, 2.2, 3.3, 4.7 **8p**; 10 **10p**; 15, 22 **12p**; 33 **15p**; 47 **12p**; 68 **20p**; 100 **19p**; 220 **26p**; 1000 **70p**; 2200 **99p**; **50V**: 68 **20p**; 100 **17p**; 220 **24p**; **40V**: 6.8 **15p**; 22 **9p**; 33 **12p**; 330, 470 **32p**; 1000 **48p**; 2200 **90p**; **25V**: 1.5, 4.7, 10, 22, 47 **8p**; 100 **11p**; 150 **12p**; 220 **15p**; 330 **22p**; 470 **25p**; 680, 1000 **34p**; 1500 **42p**; 2200 **50p**; 2200 **50p**; 3300 **76p**; 4700 **92p**;
16V:
47, 68, 100 **9p**; 125 **12p**; 330 **16p**; 470 **20p**; 680 **34p**; 1000 **27p**; 1500 **31p**; 2200 **36p**; 4700 **79p**.

TAG-END CAPACITORS: 64V: 2200 **139p**; 3300 **198p**; 4700 **245p**; **50V**: 2200 **110p**; 3300 **164p**; **40V**: 4700 **160p**; **25V**: 2200 **90p**; 3300 **98p**; 4000, 4700 **98p**; 10,000 **320p**; 15,000 **345p**; **16V**: 22,000 **350p**

POLYESTER CAPACITORS: Axial Lead Type
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8 **11p**; 10n, 15n, 18n, 22n **12p**; 33n, 47n, 68n **16p**; 150n **20p**; 220n **30p**; 330n **42p**; 470n **52p**; 680n 1uF **68p**; 2u2 **82p**.
160V: 10nF, 12n, 39n, 100n **11p**; 150n, 220n **17p**; 330n, 470n **30p**; 680n **38p**; 1uF **42p**; 1u5 **46p**; 2u2 **48p**; 4u7 **58p**.
1000V: 1nF **17p**; 10nF **30p**; 15n **40p**; 22n **36p**; 33n **42p**; 47n, 100n **42p**.

SIEMENS pcb Type Miniature poly Capacitors

250V	
1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 15n	**7p**
18n, 22n, 27n, 33n, 39n, 47n	**8p**
39n, 56n	**12p**
82n, 100n	**11p**
100V	
100n, 120n	**10p**
150n, 180n	**12p**
220n, 270n	**15p**
330n, 390n	**20p**
470n, 560n	**26p**
680r.	**30p**
1uF **34p** 2u2	**50p**

POLYESTER RADIAL LEAD CAPACITORS: 250V
10n, 15n, 22n, 27n **6p**; 33n, 47n, 68n, 100n **7p**; 150n, 220n **10p**; 330n, 470n **13p**; 680n **19p**; 1u **23p**; 1u5 **40p**; 2u2 **46p**.

FEED-THROUGH CAPACITORS
1000pF/450V **8p**

TANTALUM BEAD CAPACITORS
35V: 0.1uF, 0-22, 0-33 **15p**; 0-47, 0-68, 1-0, 1.5 **16p**; 2.2, 3-3 **18p**; 4.7, 6.8 **22p**; 10 **28p**; **16V**: 2.2, 3.3 **16p**; 4.7, 6.8, 10 **18p**; 15, **36p**; 22 **30p**; 33, 47 **40p**; 100 **75p**; **10V**: 15, 22, **26p**; 33, 47 **35p**; 100 **55p**; **6V**: 100 **42p**.

POTENTIOMETERS: Rotary, Carbon, Track 0.25W Log & Lin values.

500Ω, 1KΩ & 2KΩ (Linear only) Single Gang.	**30p**
5KΩ-2MΩ Single Gang Log & Lin	**30p**
5KΩ-2MΩ Single Gang D/P Switch	**78p**
5KΩ-2MΩ Double Gang	**89p**

MYLAR FILM CAPACITORS
100V: 1nF, 2, 4, 4nF, 10 **6p**; 15nF, 22n, 30n, 40n, 47n **7p**; 56n, 100n, 200n **9p**; **50V**: 470nF **12p**.

SLIDER POTENTIOMETERS
0-25W log and linear values 60mm

5KΩ-500KΩ single gang	**70p**
10KΩ-500KΩ dual gang	**110p**
Self Stick Graduated Bezel	**40p**

CERAMIC CAPACITORS 50V:
Range: 0-5pF to 10nF **4p**. 15nF; 22nF; 33nF; 47nF **5p**. 100nF/30V **7p**. 200nF/6V **8p**.

POLYSTYRENE CAPACITORS:
10pF to 1nF **8p**; 1.5nF to 12nF **10p**

PRESET POTENTIOMETERS

0.1W 50Ω 5MΩ Miniature Vertical & Horizontal	**7p**
0-25W 100Ω 3-3MΩ horiz. larger	**10p**
0-25W 200Ω 4-7MΩ vert.	**10p**

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ACY21/22	75
ACY28	75
ACY39/41	85
AD142	120
AD142	120
AD149	79
AD161	42
AD162	42
AF115/6	60
AF117/8	90
AF124/26	70
AF139	40
AF178	75
AF186	70
AF239	55
ASZ21	125
BC107	10
BC107B	12
BC108	10
BC108B	12
BC109	10
BC109B	12
BC109C	12
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BC117/8	20
BC119	38
BC137/9	40
BC140	30
BC142/3	30
BC147	9
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BC148	9
BC148B	10
BC149	9
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BC159	11
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BC168C	10
BC169C	10
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BC184	10
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BC183L	10
BC184L	10
BC186/7	28
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BC212L	10
BC213	10
BC213L	10
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BD112	125
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BD696A	125
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BU206	200
BU208	200
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MJ2955	70
MJE170	150
MJE180	150
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MJE370	100
MJE371	100
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TIP33C	78
TIP34A	74
TIP34C	88
TIP35A	110
TIP35C	128
TIP36A	130
TIP36C	140
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2N1670	150
2N1671B	160
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2N2303	45
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2SA715	60
2SC495	70
2SC496	70
2SC1061	250
2SC1096	85
2SC1162	30
2SC1173	125
2SC1306	100
2SC1307	150
2SC1449	85
2SC1678	140
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2SC1963	90
2SC1957	80
2SC1969	140
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2SC2029	210
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2SC2091	85
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2SC2335	225
2SC2547	30
2SC2612	225
2SD234	74
2SK45	90
2SK288	225
2SJ83	225
2SJ85	225
3N128	112
3N140	112
40097	120
40250	95
40311	60
40313	130
40315	90
40316	95
40317/20	80
40323	60
40324	100
40326/7	70
40347	90
40348	120
40360	60
40361/2	70
40407/8	75
40411	285
40412	90
40467A	130
40468	85
40594	105
40603	110
40673	75
40871/2	90

RF CHOKES Miniature PCB type

1uH, 2u2, 4u7, 10u, 22u, 33u, 47u, 100u, 220u, 330u, 470u	**30p**
1mH, 1m5, 2m2, 4m7, 10mH	**35p**
22m, 33m, 43m	**60p**
100m	**75p**

SILVER MICA (Values in pF)

2, 3-3, 4.7, 6.8, 8.2, 10, 12, 15, 18, 22, 27, 33, 39, 47, 50, 56, 68, 75, 82, 85, 100, 120, 150, 180pF	**15p each**
200, 220, 250, 270, 300, 330, 360, 390, 470, 800, 800, 820	**21p each**
1000, 1200, 1800, 2200	**30p each**
3300, 4700pF	**60p each**

MINIATURE TRIMMERS Capacitors
2-6pF, 2-10pF **22p**; 2-25pF, 5-60pF **30p**; 10-88pF **35p**.

RAM FOR BBC MICRO 4816AP 100ns
225p

RESISTORS Carbon Film Hi-Stab. 5%, miniature

	RANGE	Val	1-99	100+
¼W	2Ω2-4M7	E24	**2p**	**1p**
½W	2Ω2-4M7	E12	**2p**	**1p**
1W	2Ω2-4M7	E12	**5p**	**4p**
2% Metal Film		E24	**6p**	**4p**
1% Metal Film		E24	**8p**	**6p**

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RESISTORS Network S.I.L.
7 Commoned: (8 pins) 100Ω, 680Ω, 1K 2k2, 4K7, 10K, 47K 100K **25p**
8 Commoned: (9 pins) 150Ω, 180Ω, 270Ω, 330Ω, 1K, 2k2, 4K7, 10K, 22K, 47K & 100K **26p**.

DIODES

AA119	15
AA129	20
AAY30	15
BA100	15
BAX13	20
BY100	24
BY126	12
BY127	12
CRO33	250
OA9	40
OA47	12
OA70	12
OA79	15
OA81	20
OA85	15
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
1N914	4
1N916	5
1N4001/2	5
1N4003	6
1N4004/5	6
1N4006/7	7
1N4148	4
1N5401	15
1N5404	16
1N5406	17
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	65

NOISE Diode
Z5J **195p**

VARICAPS

BA102	50
BB105B	40
BB106	40
BB109B	45
MVAM2	165

BRIDGE RECTIFIERS

1A/50V	18
1A/100V	20
1A/400V	25
1A/600V	34
2A/50V	30
2A/200V	40
2A/400V	46
2A/600V	65
6A/100V	83
6A/400V	95
6A/600V	125
10A/200V	215
10A/600V	298
25A/200V	240
25A/600V	395
BY164	56
VM18 DIL	50

ZENERS
Range: 2V7 to 39V 400mW **8p each**
Range: 3V3 to 33V. 1.3W **15p each**

TRIACS

3A 200V	54
3A 400V	56
8A 100V	60
8A 400V	69
8A 800V	115
12A 100V	78
12A 400V	82
12A 800V	135
16A 100V	103
16A 400V	105
16A 800V	220
25V 500V	220
25A 800V	295
T2800D	120

75 SERIES

75107/8	95
75110	90
75114/5	150
75121/2	130
75150	125
75154	150
75182/3	99
75188/9	55
75322	140
75324	360
75361/3	150
75365	150
75450	86
75451/2	52
75454	85
75491/2	65

SCR THYRISTORS

5A/40V	32
5A 400V	40
5A 600V	48
8A 300V	60
8A 600V	90
12A 100V	78
12A 400V	95
12A 800V	188
BT106	150
BT116	180
C106D	38
TIC44	24
TIC45	29
TIC47	35
2N5062	32
2N5064	38
2N4444	130

DIAC
ST2 25

COMPUTER ICs

1702	350
1802CP	650
2114L-300n	90
2114L-200n	95
2147	425
2532-450n	350
2564	£10
2708	225
2716-5V	215
2732-450n	350
2764	590
3242	590
4816-100nS	225
4027	190
4116-150n	85
4116-200n	80
4118-250	325
4164-200n	500
4334-3 = CMOS	
2114-3	325
4532-3	350
4532-4	350
4816-100nS	225
4864-364K	500
4816-100nS	225
4864-364K	500
5101-450	220
6116-150nS	390
6116L 120	550
6117-100n	490
6502CPU	325
6503	600
6504 250	550
6505	600
6520PIA	100
6521	100
6522VIA	300
6530	£11
6352RRIOT	570
6545RTC	899
6551ACIA	650
6592PC	£20
6800	225
6802	250
6803	850
6804	160
6805	670
6808	520
6809	630
6810	115
6820	110
6821	110
68B21	220
6840	375
6843	£12
6845	685
6847	650
6850	110
6852	250
6854	599
6875	500
68000	£78
74C922	420
8080A	250
8085A	350
8088	£18
8118-10	225
8123	125
8155	350
8156	350
81LS95	80
81LS96	80
81LS97	80
81LS98	85
8202	£25
8205	225
8212	110
8214	425
8215	300
8216	100
8224	110
8225	£11
8226	250
8228	220
8243	270
8250	850
8251A	250
8253	400
8255	225
8256AC	£36
8257-5	400
8259	395
8271	£36
8279	385
8284	350
8288	£10
8P8304BN	250
8T26A	99
8T27	150
8T28A	120
8T31	350
8T95	90
8T97N	90
9364AP	550
9602	220
AM26LS31C	125
AM26LS32A	125
AY-3-1015	300
AY-5-1350	388
AY-5-2376	600
AY-5-2376	600
COM8017	275
COM8116	700
DM8131	275
DS3691N	320
DS88LS120N	275
DS8820	110
DS8830	110
FD1771	£15
FD1791	£22
FD1793	£23
FD1795	£28
FD1799	£28
FD1797	£28
HD26501	75
IM6402	380
INS8060N	1050
INS8154N	£9
MC1488	55
MC1489	55
MC14411	690
MC14412	790
MC3446	250
MC3447P	315
MC6845	625
MC6846	625
MK3886-2M	£7
MM1702A	300
MM5280D	695
MM5303	635
MM5307	1275
MM5387A	475
MM58174	770
MM74C922	420
RO-3-2513L	650
RO-3-2513U	650
SFF9634E	800
SFF96364	800
SPO256AL2	£18
TMS2716-3V	725
TMS6011	365
TMS9928	£20
TMS9929	£20
TMS9995	£12
ULN2003	75
UPD7002	470
Z80CPU 2.5	299
Z80ACPU 4M	300
Z80 CTC	250
Z80A CTC	260
Z80B	£11
Z80 DART	495
Z80A DART	550
Z80 DMA	675
Z80 DART	698
Z80 PIO	260
Z80A PIO	275
Z80 SIO-1	850
Z80A SIO	£9

LINEAR ICs

555CMOS	80
702	75
709C 8 pin	35
710	48
741-8 pin	14
747C 14 pin	65
748C 8 pin	36
753 8 pin	185
810	159
9400CJ	350
AD7581	£11
AY-1-1320	225
AY-1-5050	99
AY-1-5051	160
AY-1-6720	210
AY-3-1270	730
AY-3-1350	350
AY-3-8910	438
Booklet for AY-3-8910	150
AY-3-8912	625
AY-5-1230	450
AY-5-1317A	630
AY-5-1350	388
CA3011	130
CA3012	175
CA3014	275
CA3018	86
CA3019	80
CA3020	210
CA3023	210
CA3028A	95
CA3035	255
CA3036	270
CA3043	275
CA3045	365
CA3046	70
CA3048	220
CA3059	285
CA3075	213
CA3080E	70
CA3081	190
CA3086	48
CA3089E	215
CA3090AQ	375
CA3123E	165
CA3130	90
CA3140	40
CA3160	95
CA3161	160
CA3162E	450
CA3189	200
HA1336W	240
HA1388	255
ICL7106	750
ICL7107	975
ICL7611	99
ICL7660	190
ICL8038CC	300
ICL8211A	150
ICM7205A	1150
ICM7207	475
ICM7215	1050
ICM7216AJ	1950
ICM7216B	1950
ICM7216C	1950
ICM7217A	790
ICM7224	785
ICM7240	300
ICM7555	80
ICM7556	150
LA3350	250
LA4031P	340
LA4032	295
LA4400	350
LA4422	320
LC7130	340
LC7120	300
LC7137	395
LF347	150
LF351	48
LF353	95
LF355	85
LF356	95
LF357	110
LF398	475
LM10	325
LM301AO	24
LM307	45
LM308T	95
LM311	70
LM318N	150
LM319	215
LM324A	30
LM334Z	90
LM335Z	128
LM339	47
LM348	64
LM349	115
LM358	60
LM377	175
LM379	480
LM380	75
LM381N	145
LM382	115
LM384	140
LM386	90
LM387	120
LM389	95
LM393	100
LM558	75
LM725CN	325
LM733	70
LM1458	45
LM1871	325
LM2917	195
LM301	24
LM307	45
LM3302	75
LM3900	50
LM3909N	85
LM3911	125
LM3914	250
LM3915	250
LM3916	250
LM13600	110
LS7220	280
M253AA	1150
M51513L	230
M51515L	320
M51516L	475
MB3712	220
MB3756	440
MC1204	250
MC1301	79
MC1303	88
MC1304P	260
MC1310P	150
MC1445	250
MC145106	695
MC1469	300
MC1494	694
MC1495	350
MC1496L	70
MC1596	225
MC1648	290
MC1709G	90
MC3302	90
MC3340P	120
MC3360P	120
MC3401	65
MC3403	75
MC3405	150
MC3423	180
MC4016	00
MF10	350
MFC6040	75
MK50398	635
ML924	275
MSM5526	820
NE515	275
NE529	225
NE531	140
NE534	150
NE543K	225
NE544	210
NE555	16
NE556	45
NE560	325
NE561	398
NE562B	410
NE564	420
NE565A	120
NE566	155
NE567V	140
NE570	410
NE571	400
NE5532	145
NE5534A	150
OM335	750
RC4136D	69
RC4558	45
S566B	225
SAB3209	425
SAB3210	325
SAB3271	485
SAB4209	595
SG3402	295
SL490	350
SN76013	350
SN76023ND	240
SN76131	125
SN76227N	95
SN76477	420
SN76488	480
SP0256AL2	£18
SP8629	299
TA7130	150
TA7210	150
TA7204	175
TA7205	90
TA7222	150
TA7310	160
TAA621AX1	295
TAA661A	190
TAA700	275
TAA900	395
TAD100	159
TBA120S	70
TBA540Q	275
TBA550Q	330
TBA641BX or BX11	290
TBA651	190
TBA800	80
TBA810	95
TBA820	80
TBA920Q	200
TBA950	300
TBA990Q	350
TBA540	275
TC9109	775
TCA220	350
TCA270Q	350
TCA280A	220
TCA940	175
TCA965	120
TDA1004	290
TDA1008	310
TDA1022	499
TDA1024	115
TDA1034	350
TDA1490	325
TDA2002	325
TDA2004	495
TDA2020	320
TDA2030	295
TDB0701	420
TL170	50
TL061CP	40
TL062CP	60
TLO64CN	98
TLO71CP	24
TLO72CP	45
TLO74CN	100
TLO81CP	24
TLO82CP	45
TLO83CP	75
TLO84CN	90
TLO91CP	55
UA2240	120
UA78540	230
UAA170	170
UAA180	170
UAA1003-3	935
ULN2003	75
ULN2004	75
ULN2283	100
UPC575	275
UPC1025H	375
UPC1182	330
UPC1156H	275
UPC1366	195
XR2206	300
XR2207	375
XR2211	575
XR2216	675
XR2266	360
ZN414	80
ZN419E	190
ZN423E	135
ZN424E	130
ZN425E	345
ZN426E	300
ZN427E	600
ZN428E	410
ZN429E	210
ZN459	570
ZN1034E	200
ZN1040E	675
ZNA234E	850

TTL74

7400	11
7401	11
7402	11
7403	12
7404	13
7405	15
7406	20
7407	20
7408	14
7409	14
7410	14
7411	16
7412	18
7413	18
7414	24
7416	20
7417	20
7420	15
7421	20
7422	20
7423	20
7425	18
7426	18
7427	15
7428	26
7430	14
7432	22
7433	22
7437	25
7438	22
7440	15
7441	55
7442	32
7443	90
7444	90
7445	55
7446	60
7447	40
7448	45
7450	16
7451	16
7453	16
7454	16
7460	16
7470	35
7472	24
7473	28
7474	20
7475	25
7476	25
7480	48
7481	120
7482	65
7483	38
7484	70
7485	60
7486	20
7489	170
7490	20
7491	35
7492	25
7493	25
7494	35
7495	35
7496	35
7497	90
74100	80
74104	50
74105	55
74107	20
74109	25
74110	35
74111	55
74112	170
74116	60
74118	55
74119	60
74120	60
74121	25
74122	35
74123	35
74125	35
74126	35
74128	35
74132	30
74136	28
74141	55
74142	175
74143	210
74144	210
74145	50
74147	75
74148	60
74150	50
74151	40
74153	40
74154	55
74155	40
74156	40
74157	30
74159	80
74160	60
74161	48
74162	40
74163	40
74164	40
74165	48
74166	48
74167	150
74170	125
74172	250
74173	60
74174	54
74175	55
74176	40
74177	45
74178	80
74179	80
74180	40
74181	115
74182	60
74184	90
74185	95
74186	470
74188	250
74190	48
74191	46
74192	46
74193	45
74194	40
74195	40
74196	48
74197	40
74198	80
74199	84
74221	54
74246	120
74247	120
74248	120
74249	120
74251	65
74259	150
74265	55
74273	150
74276	120
74278	100
74279	50
74283	50
74284	155
74285	155
74290	105
74293	80
74297	236
74298	100
74351	195
74365	30
74366	30
74367	30
74368	30
74390	75
74393	90
74430	95

74C

74C244	195
74C245	195
74C373	240
74C374	245
74C922	420

74L

74L00	68
74L04	85
74L30	50
74L47	380
74L75	145
74L85	349
74L121	165
74L123	325

74S

74S00	38
S02	30
S03	30
S04	30
S05	60
S08	60
S20	40
S32	70
S74	75
S86	85
S112	85
S114	85
S132	110
S133	60
S138	115
S139	115
S157	250
S158	210
S188	140
S189	140
S194	320
S195	795
S201	320
S225	510
S241	300
S244	290
S251	70
S257	250
S262	850
S287	300
S288	210
S289	195
S301	350
S412	380
S470	325
S471	620
S472	1150
S475	825
S571	620

74LS

LS00	11
LS01	11
LS02	11
LS03	12
LS04	12
LS05	13
LS08	12
LS09	12
LS10	13
LS11	13
LS12	13
LS13	20
LS14	28
LS15	13
LS20	13
LS21	13
LS22	13
LS26	14
LS27	13
LS28	14
LS30	13
LS32	13
LS33	15
LS37	15
LS38	15
LS40	13
LS42	28
LS47	35
LS48	45
LS49	50
LS51	14
LS54	14
LS55	14
LS63	120
LS73	18
LS74	18
LS75	20
LS76	18
LS78	18
LS83	36
LS85	42
LS86	16
LS90	28
LS91	60
LS92	32
LS93	28
LS95	40
LS96	95
LS107	40
LS109	28
LS112	28
LS113	22
LS114	22
LS122	36
LS123	36
LS124	90
LS125	24
LS126	25
LS132	35
LS133	30
LS136	24
LS138	25
LS139	32
LS145	70
LS147	100
LS148	70
LS151	40
LS153	40
LS155	35
LS156	36
LS157	27
LS158	30
LS160	32
LS161	35
LS162	35
LS163	35
LS164	40
LS165	50
LS166	65
LS168	84
LS170	75
LS173	65
LS174	50
LS175	45
LS181	90
LS183	180
LS190	45
LS191	45
LS192	45
LS193	45
LS194	35
LS195	35
LS196	45
LS197	45
LS200	275
LS202	275
LS221	55
LS240	65
LS241	65
LS242	65
LS243	65
LS244	55
LS245	70
LS247	50
LS248	55
LS249	55
LS251	30
LS253	35
LS257	30
LS258	35
LS259	58
LS260	22
LS261	100
LS266	20
LS273	54
LS275	125
LS279	30
LS280	90
LS283	40
LS290	60
LS293	40
LS295	75
LS298	80
LS299	150
LS300	175
LS302	175
LS320	200
LS323	195
LS324	168
LS325	295
LS326	240
LS327	240
LS347	95
LS348	90
LS352	62
LS353	62

SWITCHES

TOGGLE: 2A, 250V.

SPST	**33p**
DPDT	**44p**

SUB-MIN TOGGLE

SPST on/off	**54p**
SPDT c/over	**60p**
SPDT centre off	**85p**
SPDT biased both ways	**105p**
DPDT 6 tags	**75p**
DPDT centre off	**88p**
DPDT biased both ways	**145p**
DPDT 3 positions on/on/on	**185p**
3-pole 2 way	**205p**

SLIDE 250V:

DPDT 1A	**14p**
DPDT 1A c/off	**15p**
DPDT ½A	**13p**

PUSHBUTTON 6A
with 10mm Button

SPDT latching	**99p**
DPDT latching	**145p**
SPDT moment	**99p**
DPDT moment	**145p**

Mini Non Locking

Push to Make	**15p**
Push to Break	**25p**

DIL SWITCHES
(SPST) 4 way **70p**; 6 way **85p**; 8 way **90p**; 10 way **145p**.
(SPDT) 4 way **190p**.

ROTARY SWITCHES:
(Adjustable Stop type)
1 pole/2 to 12 way; 2p/2 to 6 way; 3 pole/2 to 4 way; 4p/2 to 3 way **45p**

ROTARY: Mains DP 250V 4 Amp on/off **56p**

ROTARY: (Mak-a-switch)
Make a multiway switch. Shafting assembly has adjustable stop. Accommodates up to 6 wafers (max 6 pole/12 way + DP switch).
Mechanism only **90p**

WAFERS: (make before break) to fit the above switch mechanism.
1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6-/2 way **65p**
Mains DP 4A Switch to fit **45p**
Spacers **4p**. Screen **6p**

ROCKER: 5A/250V SPST	**28p**
ROCKER: 10A/250V SPDT	**38p**
ROCKER: 10A/250V DPDT c/off	**95p**
ROCKER: 10A/250V DPST with neon	**85p**

THUMBWHEEL Mini front mounting

Decade Switch Module	**220p**
B.C.D. Switch Module	**275p**
Mounting Cheeks (per pair)	**75p**

ETI PROJECTS
We stock most of the parts

JUMPER LEADS (Ribbon Cable Assembly)

Length	14 pin	16 pin	24 pin	40 pin
Single ended DIP (Header Plug) Jumper				
24 inches	**145p**	**165p**	**240p**	**380p**
Double ended DIP (Header Plug) Jumper				
6 inches	**185p**	**205p**	**300p**	**465p**
12 inches	**198p**	**215p**	**315p**	**490p**
24 inches	**210p**	**235p**	**345p**	**540p**
36 inches	**230p**	**250p**	**375p**	**595p**

IDC Header Socket Jumper Leads 24"

	20 pin	26 pin	34 pin	40 pin
Single ended	**160p**	**200p**	**260p**	**300p**
Double ended	**290p**	**370p**	**480p**	**525p**

VEROBOARD 0.1in

	clad	plain
2½ × 3¼"	**80p**	
2½ × 5"	**91p**	—
3¾ × 3¾"	**91p**	—
3¾ × 5"	**106p**	**87p**
3¾ × 17"	**380p**	**232p**
4¾ × 17"	**470p**	—
Pkt. of 100 pins		**50p**
Spot face cutter		**135p**
Pin insertion tool		**178p**

VQ Board	**180**
DIP Board	**360**
Vero Strip	**374**

PROTO DECs

Veroblock	**405p**
S-Dec	**360p**
Eurobreadboard	**520p**
Bimboard 1	**575p**
Superstrip SS2	**1350p**

VERO WIRING PEN + spoool **340p**
Spare spool **75p**
Combs **6p**

DALO ETCH RESIST PEN
Plus spare tip **90p**

FERRIC CHLORIDE
1 lb bag Anhydrous
195p + 50p P&P

ULTRASONIC TRANSDUCER
40KHz **325 pr**

COPPER CLAD BOARDS

Fibre glass	Single-sided	Double-sided	S.R.B.P. 9.5" × 8.5"
6" × 6"	**90p**	**110p**	**95p**
6" × 12"	**150p**	**195p**	

DIL SOCKETS

	Low Prof	Wire Wrap
8pin	**8p**	**25p**
14pin	**10p**	**35p**
16pin	**10p**	**42p**
18pin	**16p**	**52p**
20pin	**20p**	**60p**
22pin	**22p**	**65p**
24pin	**25p**	**70p**
28pin	**28p**	**80p**
40pin	**30p**	**99p**

EDGE CONNECTORS

	.1	.156
2 × 15 way	—	**140p**
2 × 18 way	**180p**	**145p**
2 × 22 way	**199p**	**200p**
2 × 23 way	175p	—
2 × 25 way	225p	**220p**
2 × 28 way	190p	—
2 × 30 way	245p	—
2 × 36 way	295p	—
2 × 40 way	315p	—
2 × 43 way	395p	—
2 × 75 way	550p	—

ANTEX SOLDERING IRON

C-15W	**450p**	CX17W	**475p**
CCN-15W	**495p**	CX25W	**500p**

Spare tips, assorted sizes	**65p**
Spare Elements	**210p**
Iron stand with sponge	**165p**

SIL SOCKET
0.1" pitch
20 way
65p

IDC CONNECTORS

	PCB Plugs with latch Pins Strt	PCB Plugs with latch pins Angle	Female Header Plug	Female Card Edge Connect
10 way	**90p**	**99p**	**85p**	120p
16 way	**130p**	**150p**	**110p**	—
20 way	**145p**	**166p**	**125p**	195p
26 way	**175p**	**200p**	**150p**	240p
34 way	**205p**	**236p**	**169p**	320p
40 way	**220p**	**250p**	**190p**	340p
50 way	**235p**	**270p**	**200p**	395p
60 way	—	—	**230p**	495p

EURO CONNECTORS

	Female Socket Strt. Pins	Female Socket Angle Pins	Male Plug Strt. Pins	Male Plug Angle Pins
DIN41617 31way	**170p**	—	—	**175p**
DIN41612 2 × 32 A + B	**285p**	**325p**	**220p**	**295p**
DIN41612 2 × 32 A + C	**300p**	**340p**	**240p**	**300p**
DIN41612 3 × 32 A + B + C	**360p**	**385p**	**280p**	**400p**

DIL PLUG (Header)

	Solder	IDC
14pin	**40p**	**99p**
16pin	**49p**	**105p**
24pin	**88p**	**178p**
40pin	**250p**	**255p**

RIBBON CABLE
price per foot

	Grey	Color
10 way	**12p**	**22p**
16 way	**18p**	**32p**
20 way	**25p**	**40p**
24 way	**36p**	**50p**
34 way	**48p**	**60p**
40 way	**55p**	**75p**
50 way	**65p**	**90p**
64 way	**85p**	**110p**

ZIF DIL SOCKETS

24 pin	**575p**
28 pin	**820**
40 pin	**975p**

D CONNECTORS: Miniature

	9 way	15way	25way	37way
Plugs				
Solder lugs	**80p**	**110p**	**160p**	**250p**
Angle Pins	**160p**	**210p**	**250p**	**355p**
W/Wrap Pins	**120p**	**130p**	**195p**	**295p**
Sockets				
Solder lugs	**110p**	**160p**	**210p**	**350p**
Angled Pins	**165p**	**2 5p**	**290p**	**440p**
W/Wrap Pins	**150p**	**180p**	**240p**	**420p**
Covers	**95p**	**95p**	**95p**	**110p**

IDC 25 way plug **385p** Skt **450p**

25 way 'D' CONNECTOR
Jumper Lead Cable Assembly

18" long, Single end, Male	**495p**
18" long, Single end, Female	**525p**
36" long, Double Ended, M/M	**1025p**
36" long, Double Ended, F/F	**1050p**
36" long, Double Ended, M/F	**995p**

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FSD
60 × 46 × 35mm
0-50μA
0-100μA
0-500μA
0-1mA
0-5mA
0-10mA
0-50mA
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0-500mA
0-1A
0-2A
0-25V
0-50V AC
0-300V AC
"S"
"VU"
495p each

CRYSTALS

32.768KHz	**100**
100KHz	**236**
200KHz	**268**
455KH	**370**
1MHz	**275**
1.008M	**275**
1.28MHz	**392**
1.6MHz	**395**
1.8NHz	**395**
1.8432M	**200**
2.0MHz	**225**
2.4576M	**200**
3.278M	**150**
3.5794M	**98**
3.6864M	**300**
4.0MHz	**150**
4.032MHz	**290**
4.80MHz	**200**
4.194304M	**200**
4.433619M	**100**
5.0MHz	**160**
5.185MHz	**300**
5.24288M	**390**
6.0MHz	**140**
6.144MHz	**150**
6.5536MHz	**225**
7.0MHz	**150**
7.168MHz	**250**
7.68MHz	**200**
8.0MHz	**150**
8.08333M	**395**
8.86723M	**175**
9.00MHz	**150**
10.0MHz	**175**
10.24MHz	**200**
10.7	**150**
12.0NHz	**175**
12.528M	**300**
14.31814M	**170**
16.0MHz	**200**
18.0MHz	**180**
18.432M	**150**
20.0MHz	**200**
19.968MHz	**150**
24.0MHz	**170**
24.930MHz	**325**
26.69M	**150**
27.648M	**170**
27.145M	**190**
38.66667M	**175**
48.0MHz	**170**
100.0MHz	**295**
116.0MHz	**250**

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S.P.C.O.
RL6-91 170Ω coil, 7V5 to 12V DC; 380V/6A AC; 1300VA/50W **210p**
D.P.C.O.
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RL6-111 170Ω coil, 8V-14V; 250V AC 5A. **220p**
RL6-114 1740Ω coil, 17V5-29V 250V 5A AC **222p**

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Centronics Parallel 36 Way solder	530
Centronic Parallel 36 way IDC	495

BUZZERS, miniature, solid-state 6V: 9V & 12V **70p**

PIEZOI TRANSDUCERS
PB2720 **55p**

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Miniature, 0.3W: 8Ω
2in, 3¼in, 2½in, 3in **80p**
2½in 40Ω, 64Ω or 80Ω **80p**

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Wideband 8MHz	**425p**

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3-0-3V; 6-0-6V; 9-0-9V; 12-0-12V; 15-0-15V @ 100mA **98p**

pcb mounting. Miniature, Split Bobbin

3VA: 2x6V-0.25A; 2x9V-0.15A; 2x12V-0.12A; 2x15V-0.1A **200p**

6VA: 2x6V-0.5A; 2x9V-0.3A; 2x12V-0.25A; 2x15V-0.2A **270p**

Standard Split Bobbin type:

6VA: 2x6V-0.5A; 2x9V-0.4A; 2x12V-0.3A; 2x15V-0.25A **220p**

12VA: 2x4.5V-1.3A; 2x8V-1A; 2x9V-0.6A; 2x12V-0.5A; 2x15V-0.4A; 2x20V-0.3A **295p** (35p p&p)

24VA: 2x6V-1.5A; 2x9V-1.2A; 2x12V-1A; 2x15V-0.8A; 2x20V-0.6A **330p** (60p p&p)

50VA: 2x6V-4A; 2x9V-2.5A; 2x12V-2A; 2x15V-1.5A; 2x20V-1.2A; 2x25V-1A; 2x30V-0.8A **465p** (60p p&p)

Specially wound for Multirail Computer PSUs
50VA: Outputs +5V/5A; +12V, +25V, −5V, −12V at 1A 575p (60p p&p)

100VA: 2x12V-4A; 2x15V-3A; 2x20V-2.5A; 2x25V-2A; 2x30V-1.5A; 2x50V-1A **920p** (75p p&p charge to be added over and above our normal postal charge).

VOLTAGE REGULATORS

1A	TO220 +ve		Plastic Casing −ve	
5V	7805	**40p**	7905	**45p**
12V	7812	**40p**	7908	**60p**
15V	7815	**40p**	7912	**45p**
18V	7818	**40p**	7915	**45p**
24V	7824	**40p**	7918	**45p**
			7924	**45p**

100mA TO92 Plastic package

5V	78LO5	**30p**	79LO5	**60p**
6V	78LO6	**30p**	—	
8V	78LO8	**30p**	—	
12V	78L12	**30p**	79L12	**60p**
15V	78L15	**30p**	79L15	**60p**

LM300H	**170p**	TAA550	**50p**
LM304H	**170p**	TDA1412	**150p**
LM305H	**140p**	78H05 +5V/5A	**550p**
LM309K	**135p**	78H12 +12V/5A	
LM317K	**320p**		**580p**
LM317KP	**99p**	78HG +5V to +25V	
LM323K	**450p**	5A	**599p**
LM337	**175p**	79HG +2.25V to 24V	
LM723 Var	**38p**	5A	**685p**

SOLDERCON PINS
Ideal for making SIL or DIL Sockets

100 pins	**75p**
500 pins	**350p**

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3 × 2 × 1"	**65p**
4 × 2¼ × 2"	**85p**
4 × 2¾ × 2½"	**103p**
4 × 4 × 2"	**105p**
4 × 4 × 2½"	**120p**
5 × 4 × 1½"	**99p**
5 × 4 × 2½"	**120p**
5 × 2¾ × 1½"	**90p**
5 × 2¾ × 2½"	**130p**
6 × 4 × 2"	**120p**
6 × 4 × 3"	**150p**
7 × 5 × 3"	**180p**
8 × 6 × 3"	**210p**
10 × 4 × 3"	**240p**
10 × 7 × 3"	**275p**
12 × 5 × 3"	**260p**
12 × 8 × 3"	**295p**

CMOS

4000	10
4001	10
4002	12
4006	50
4007	14
4008	32
4009	24
4010	24
4011	10
4012	16
4013	20
4014	46
4015	40
4016	20
4017	32
4018	45
4019	25
4020	42
4021	40
4022	40
4023	13
4024	32
4025	13
4026	80
4027	20
4028	39
4029	45
4030	15
4031	125
4032	80
4033	125
4034	140
4035	45
4036	275
4037	115
4038	110
4039	250
4040	40
4041	40
4042	40
4043	40
4044	40
4045	105
4046	46
4047	40
4048	40
4049	25
4050	25
4051	46
4052	60
4053	50
4054	85
4055	86
4056	85
4057	1915
4059	436
4060	45
4061	1195
4062	995
4063	85
4066	24
4067	245
4068	14
4069	16
4070	13
4071	13
4072	13
4073	15
4075	13
4076	50
4077	13
4078	15
4081	13
4082	13
4085	50
4086	60
4089	125
4093	20
4094	70
4095	95
4096	70
4097	290
4098	75
4099	110
4160	95
4161	99
4162	99
4163	99
4174	99
4175	105
4194	105
4408	790
4409	790
4410	725
4411	675
4412	775
4415	480
4419	280
4422	770
4435	850
4440	999
4450	350
4451	350
4490	350
4500	675
4501	28
4502	60
4503	40
4504	75
4505	185
4506	35
4507	35
4508	130
4510	46
4511	45
4512	50
4513	199
4514	115
4515	115
4516	55
4517	275
4518	40
4519	30
4520	50
4521	110
4522	125
4526	70
4527	65
4528	70
4529	150
4530	90
4531	130
4532	70
4534	455
4536	275
4538	90
4539	110
4541	140
4543	80
4544	150
4548	40
4549	375
4553	245
4554	190
4555	35
4556	35
4557	320
4558	120
4559	395
4560	160
4561	104
4562	495
4566	165
4568	250
4569	175
4572	30
4580	460
4581	250
4582	99
4583	99
4584	48
4585	99
4597	330
4599	290
40085	90
40097	45
40098	193
40100	215
40101	130
40102	140
40103	175
40104	95
40105	110
40106	46
40107	60
40108	450
40109	100
40110	300
40114	240
40161	194
40163	65
40174	65
40175	75
40181	220
40182	90
40192	90
40193	68
40194	90
40195	72
40244	195
40245	195
40257	195
40373	240
40374	245
45106	595

OPTO

LS400C	255
OCP71	120
ORP12	86
ORP61	85
2N5777	45
BPX25	195
BPW21	295
BPX65	270

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.2" Green, Yellow or Amber	14
0.2" Bi colour Red/Green	65
Green/Yellow	78
0.2" Tri colour Red/Green/Yellow	85
Hi-Brightness Red	59
Flashing red 0.2" red	55
Square LEDs, Red, Green, Yellow	30
Rectangle Stackable LEDs Red, Green or Yell	18
Triangular LEDs Red	18
Green or yellow	22
LD271 Infra Red	46
SFH205 Detector	118
TIL32 Infra Red	58
TIL78 Detector	60
TIL38	45
TIL100	80
BARGRAPH. Red 10 segments	225
ISOLATORS	
IL74	55
ILD74	99
ILQ74	185
TIL111/2/4	90
TIL117	125
4N33 Photo Darlington	136
7 Segment Displays	
TIL307	675
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TIL313 .3" CC	105
TIL321 .5" CA	115
TIL322 .5" CC	115
DL704 .3" CC	99
DL707 .3" CA	99
FND357 Red	120
FND500	115
.3" Green CA	150
.6" Green CA	215
.3" ± 1 Red CA	150
.3" ± 1 Green CA	150
DVM176	1885
LCD 3½ Digits	495
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elektor decoder

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ADV = Advertisements
ADM = Administration
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ABC

What is 10 n?
What is the EPS service?
What is the TQ service?
What is a missing link?

Semiconductor types
Very often, a large number of equivalent semiconductors exist with different type numbers. For this reason, 'abbreviated' type numbers are used in Elektor wherever possible:

- '741' stand for μA 741, LM 741, MC 1741, MIC 741, RM 741, SN 72741, etc.
- 'BC 107B', 'BC 237B', 'BC 547B' all refer to the same 'family' of almost identical better-quality silicon transistors. In general, any other member of the same family can be used instead.

BC 107 (-8, -9) families:
BC 107 (-8, -9), BC 147 (-8, -9), BC 207 (-8, -9), BC 237 (-8, -9), BC 317 (-8, -9), BC 347 (-8, -9), BC 547 (-8, -9), BC 171 (-2, -3), BC 182 (-3, -4), BC 382 (-3, -4), BC 437 (-8, -9), BC 414

BC 177 (-8, -9) families:
BC 177 (-8, -9), BC 157 (-8, -9), BC 204 (-5, -6), BC 307 (-8, -9), BC 320 (-1, -2), BC 350 (-1, -2), BC 557 (-8, -9), BC 251 (-2, -3), BC 212 (-3, -4), BC 512 (-3, -4), BC 261 (-2, -3), BC 416.

Resistors and capacitor values
When giving component values, decimal points and large numbers of zeros are avoided wherever possible. The decimal points is usually replaced by one of the following abbreviations:

p (pico-) = 10^{-12}
n (nano-) = 10^{-9}
μ (micro-) = 10^{-6}
m (milli-) = 10^{-3}
k (kilo-) = 10^{3}
M (mega-) = 10^{6}
G (giga-) = 10^{9}

A few examples:
Resistance value 2k7: 2700 Ω.
Resistance value 470: 470 Ω.
Capacitance value 4p7: 4,7 pF or 0.000 000 000 004 7 F . . .
Capacitance value 10 n: this is the international way of writing 10,000 pF or .01 μF, since 1 n is 10^{-9} farads or 1000 pF;
Resistors are ¼ Watt 5% carbon types, unless otherwise specified. The DC working voltage of capacitors (other than electrolytics) is normally assumed to be at least 60 V. As a rule of thumb, a safe value is usually approximately twice the DC-supply voltage.

Test voltages
The DC test voltages shown are mesured with a 20 kΩ/V instrument, unless otherwise specified.

U, not V
The international letter symbol 'U' for voltage is often used instead of the ambiguous 'V'. 'V' is normally reserved for 'volts'. For instance: $U_b = 10$ V, not $V_b = 10$ V.

Mains voltages
No mains (power line) voltages are listed in Elektor circuits. It is assumed that our readers know what voltage is standard in their part of the world!
Readers in countries that use 60 Hz should note that Elektor circuits are designed for 50 Hz operation. This will not normally be a problem; however, in cases where the mains frequency is used for synchronisation some modification may be required.

Technical services to readers

- **EPS service.** Many Elektor articles include a lay-out for a printed circuit board. Some — but not all — of these boards are available ready-etched and predrilled. The 'EPS print service' in the current issue always gives a complete list of available boards.
- **Technical queries.** Members of the technical staff are available to answer technical queries (relating to articles published in Elektor) by telephone on Monday's from 13.30 to 16.15. Letters with technical queries should be addressed to: Dept. TQ. Please enclose a stamped, self addressed envelope; readers outside U.K. please enclose an IRC instead of stamps.
- **Missing link.** Any important modifications to, additions to, improvements to or corrections in Elektor circuits are generally listed under the heading 'Missing Link' at the earliest opportunity.

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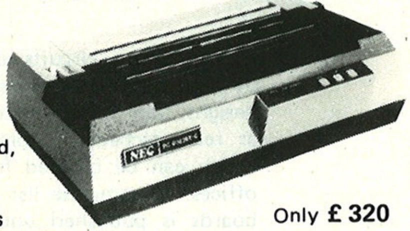

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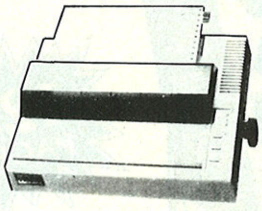

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services to readers

EPS print service

Many Elektor circuits are accompanied by printed circuit designs. Some of these designs, but not all, are also available as ready-etched and pre-drilled boards, which can be ordered from any of our offices. A complete list of the available boards is published under the heading 'EPS print service' in every issue. Delivery time is approximately three weeks.

It should be noted however that only boards which have at some time been published in the EPS list are available; the fact that a design for a board is published in a particular article does not necessarily imply that it can be supplied by Elektor.

Technical queries

Please enclose a stamped, self-addressed envelope; readers outside UK please enclose an IRC instead of stamps.

Letters should be addressed to the department concerned – TQE (Technical Queries). Although we feel that this is an essential service to readers, we regret that certain restrictions are necessary:

1. Questions that are not related to articles published in Elektor cannot be answered.
2. Questions concerning the connection of Elektor designs to other units (e.g. existing equipment) cannot normally be answered. An answer can only be based on a comparison of our design specifications with those of the other equipment.
3. Questions about suppliers for components are usually answered on the basis of advertisements, and readers can usually check these themselves.
4. As far as possible, answers will be on standard reply forms.

We trust that our readers will understand the reasons for these restrictions. On the one hand we feel that all technical queries should be answered as quickly and completely as possible; on the other hand this must not lead to overloading of our technical staff as this could lead to blown fuses and reduced quality in future issues.

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8243	210p
8251	300p
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8257	450p
8259	450p
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LM308A	95p
LM311N	66p
LM324	35p
LM339	50p
LM348	75p
LM358	60p
LM380	95p
LM381	150p
LM393	90p
LM3909	85p
MC1310P	210p
MC1455	66p
MC1456	135p
MC1458	35p
MC3242A	630p
MC3302	95p
MC3340	120p
MC3401	65p
MC3403	70p
MC3456	107p
MC3480	580p
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TDA1004	290p
TL061	40p
TL062	60p
TL064	98p
TL071	30p
TL072	50p
TL074	100p
TL081	25p
TL082	45p
TL084	95p
UPC575	149p
UPC1167	158p
UPC2002C	285p
UPD7002	450p
ZN414	100p

VOLTAGE REGULATORS

+ Ve	
100mA	
78L05	30p
78L08	30p
78L12	30p
78L15	30p
500mA	
78M05	40p
78M06	55p
78M08	55p
78M12	50p
78M15	50p
78M18	55p
78M24	55p
1A	
7805	45p
7806	65p
7808	65p
7812	45p
7815	45p
7818	65p
7824	65p
– Ve	
100mA	
79L05	35p
79L12	35p
79L15	35p
1A	
7905	60p
7906	70p
7908	70p
7912	60p
7915	60p
7918	60p
7924	60p

TRANSISTORS

BC107	12p
BC107B	15p
BC108	12p
BC108B	15p
BC109	12p
BC109B	15p
BC109C	15p
BC147	9p
BC157	9p
BC158	9p
BC177	25p
BC178	25p
BC179	25p
BC182	10p
BC182A	10p
BC182B	10p
BC183A	10p
BC183C	10p
BC184	10p
BC184C	10p
BC212	10p
BC212A	10p
BC212B	10p
BC213A	10p
BC213C	10p
BC214	10p
BC214C	10p
BC237A	12p
BC237C	12p
BC238	12p
BC238A	12p
BC238B	12p
BC238C	12p
BC239	12p
BC307A	15p
BC307C	15p
BC308	15p
BC308A	15p
BC308B	15p
BC308C	15p
BC309	15p
BC309C	15p
BC327	15p
BC328	15p
BC337	15p
BC338	15p
BC477	28p
BCY70	18p
BCY71	20p
BCY72	20p
BD135	42p
BD136	45p
BD139	40p
BD140	40p
BD165	45p
BD166	45p
BD169	45p
BD170	45p
BD538	95p
BD677	60p
BD678	60p
BD679A	60p
BD680A	65p
BFY50	24p
BFY51	24p
BFY90	85p
BF244A	30p
BSX19	28p
BSX20	20p
MJ2955	95p
MJE241	80p
MJE251	80p
MJE340	50p
MJE350	90p
MJE370	95p
MJE520	90p
MJE2955	90p
MJE3055	65p
MPF102	45p
MRF475	290p
MPS2369	25p
MPS3640	30p
MPS3646	30p
MPSA06	20p
MPSA12	35p
MPSA13	20p
MPSA14	20p
MPSA18	20p
MPSA27	45p
MPSA42	25p
MPSA56	25p
MPSA63	30p
MPSA64	45p
MPSA77	50p
MPSA92	30p
TIP29	35p
TIP29A	35p
TIP29B	55p
TIP29C	40p
TIP30	50p
TIP30A	35p
TIP30B	50p
TIP30C	40p
TIP31A	40p
TIP31B	42p
TIP31C	45p
TIP32	50p
TIP32A	45p
TIP32B	60p
TIP32C	45p
TIP33	65p
TIP33A	65p
TIP33B	70p
TIP33C	75p
TIP34	75p
TIP34A	75p
TIP34B	99p
TIP34C	90p
TIP35	160p
TIP35A	165p
TIP35B	170p
TIP35C	185p
TIP36	170p
TIP36A	175p
TIP36B	185p
TIP36C	199p
TIP41	50p
TIP41A	50p
TIP41B	60p
TIP41C	50p
TIP42	58p
TIP42A	60p
TIP42B	75p
TIP42C	65p
TIP47	50p
TIP48	50p
TIP49	50p
TIP50	48p
TIP110	30p
TIP111	75p
TIP112	50p
TIP115	40p
TIP116	73p
TIP117	45p
TIP120	39p
TIP121	80p
TIP122	75p
TIP125	45p
TIP126	80p
TIP140	130p
TIP141	140p
TIP142	180p
TIP145	140p
TIP146	180p
TIP147	170p
TIP2955	70p
TIP3055	70p
TIS43	30p
TIS88A	48p
TIS151	50p
2N1613	25p
2N1711	25p
2N1893	35p
2N2218A	45p
2N2219	25p
2N2221	30p
2N2221A	30p
2N2222	25p
2N2222A	25p
2N2369A	20p
2N2904A	25p
2N2905	25p
2N2905A	25p
2N2906A	25p
2N2907A	25p
2N3053	30p
2N3054	70p
2N3055	45p
2N3439	80p
2N3440	60p
2N3771	160p
2N3772	160p
2N3773	250p
2N3819	25p
2N3821	120p
2N3822	120p
2N3823	95p
2N3824	95p
2N3866	90p
2N3903	15p
2N3904	15p
2N3905	15p
2N3906	15p
2N4123	25p
2N4125	25p
2N4391	70p
2N4392	70p
2N4400	20p
2N4401	25p
2N4402	25p
2N4403	25p
2N4410	45p
2N4416	95p
2N4856	80p
2N4857	80p
2N4918	95p
2N4919	120p
2N4920	130p
2N4921	105p
2N4922	95p
2N4923	95p
2N5190	75p
2N5191	75p
2N5192	75p
2N5193	90p
2N5194	90p
2N5195	90p
2N5400	40p
2N5401	40p
2N5415	85p
2N5416	90p
2N5457	35p
2N5458	35p
2N5459	35p
2N5460	35p
2N5551	40p
2SC495	60p
2SC1306	95p
2SC1678	105p
2SC2028	75p
2SC2078	105p
VN10KM	65p
40673	95p

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PCIM177 Frequency Counter
5 Digits, 0.35"
FM, SW, MW, MHz, KHz
Annunciators
Sample and Hold Capability
Reset Capability
25 Selectable IF Offsets
Prescaler Available
Incandescent Backlighting
Supply Voltage 5v
Operating Current 4mA
£18.85

PCIM176 Digital Meter Module
3½ Digits, 0.5"
+, – and Decimal Point
200mV Full Scale Input
True Differential Input
Guaranteed "0" Reading
Single 9v Operation
Power Consumption 20mW
Accuracy 0.15%, +/– 1 Count
Temperature Drift 80ppm/C
Low Battery Indicator
Incandescent Backlighting
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Modules are supplied with Data Sheet.

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A 10m coil of 1mm core optical fibre cable sheathed in black polyethylene for protection **£4.95**

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- Draw your artwork on 0.1" grid
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EC941	0.031" Lines
EC942	0.039" Lines
EC943	0.049" Lines
EC944	0.061" Lines
EC945	0.079" Lines
EC946	0.100" Lines
EC947	0.124" Lines
EC950/1	0.031" 90° Bends
EC950/2	0.061" 90° Bends
EC952/1	0.031" 30°,45°,60° Bends
EC952/2	0.061" 30°,45°,60° Bends
EC908	0.063" Pads
EC910	0.094" Pads
EC911	0.189" Pads
EC960/1	TO-5 Transistor Pads
EC993/1	IC Pads
EC997/1	IC Pads with tracks between pads

5 identical sheets in sealed pack	195p
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Alfac knife	180p
Spare Blades (pack of 10)	280p
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Alfac Precision Grids Polyester film, matt finish 0.14mm thickness, 20 lines/in	
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Double Sided Fibreglass Board 1/16" thickness, 1oz Copper	
5" × 4"	25p
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3mm Red TIL209	10p
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TIL32 Emitter	54p
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TIL78 Phototransistor	54p
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80 Characters per Second
Friction and Tractor Feed
High Resolution 960 Dots/Line
Auto Underlining
Subscripts and Superscripts
£320
Securicor £6

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C2N Cassette Unit
Introduction to Basic (Part 1)
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64K RAM, 26K ROM
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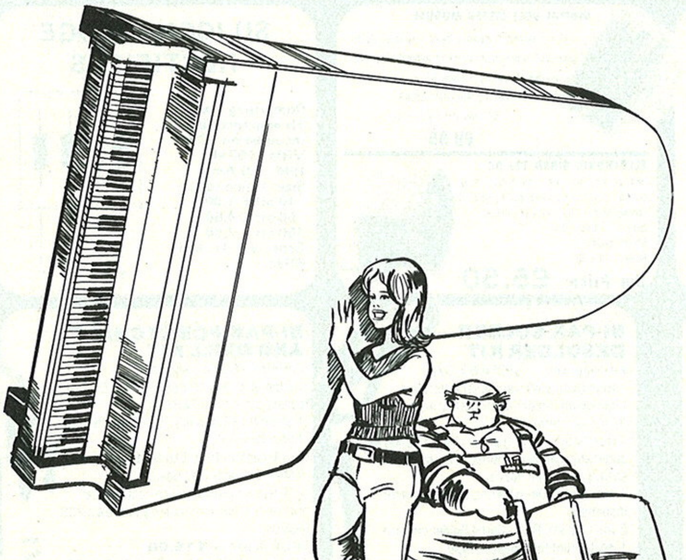

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- ALL GOODS GUARANTEED BRAND NEW AND TO SPECIFICATION
- APPOINTED SIEMENS DISTRIBUTORS

I.Cs – COMPUTER & ANALOGUE

COMPUTER

74LS

74LS00	11
74LS02	11
74LS04	12
74LS05	12
74LS08	12
74LS10	12
74LS11	12
74LS14	30
74LS20	12
74LS30	12
74LS32	14
74LS37	14
74LS38	15
74LS42	28
74LS47	56
74LS51	14
74LS73	18
74LS74	18
74LS75	22
74LS76	19
74LS85	48
74LS86	20
74LS90	27
74LS92	32
74LS93	24
74LS107	40
74LS112	22
74LS123	38
74LS125	29
74LS126	27
74LS132	40
74LS136	25
74LS137	110
74LS138	30
74LS139	35
74LS145	70
74LS148	89
74LS151	40
74LS153	40
74LS153	40
74LS155	38
74LS156	36
74LS157	30
74LS161	37
74LS163	36
74LS164	43
74LS165	60
74LS166	90
74LS173	55
74LS174	45
74LS175	40
74LS191	50
74LS193	40
74LS195	39
74LS196	48
74LS197	60
74LS221	51
74LS240	55
74LS241	55
74LS242	75
74LS243	75
74LS244	60
74LS245	85
74LS251	55
74LS253	43
74LS257	35
74LS259	84
74LS266	28
74LS273	60
74LS279	40
74LS299	250
74LS367	34
74LS368	24
74LS373	84
74LS374	68
74LS378	60
74LS393	60

7400

7400	11
7401	11
7402	12
7403	12
7404	13
7405	15
7406	20
7407	20
7408	14
7409	14
7410	14
7413	18
7414	20
7420	15
7430	14
7440	14
7442	32
7443	60
7444	60
7447	36
7448	40
7450	14
7451	14
7453	14
7454	14
7460	14
7470	24
7472	26
7473	26
7474	23
7475	32
7476	30
7480	35
7482	65
7482	65
7483	38
7485	60
7486	20
7489	159
7490	28
7491	35
7492	25
7493	25
7494	35
7495	35
7496	40
74100	80
74104	40
74107	22
74121	24
74123	40
74125	34
74126	33
74141	51
74151	40
74154	60
74155	39
74156	40
74157	30
74190	48
74192	48
74193	48
74393	95

CMOS

4000	10
4001	10
4002	12
4006	50
4007	14
4008	40
4009	24
4010	24
4011	12
4012	15
4013	20
4014	46
4015	40
4016	20
4017	35
4018	45
4019	25
4020	42
4021	40
4022	35
4023	14
4024	32
4025	14
4026	80
4027	20
4028	39
4029	45
4030	16
4041	44
4042	40
4043	40
4044	40
4046	46
4049	23
4050	23
4060	45
4069	14
4070	14
4071	14
4072	14
4081	14
4082	14
4093	20
4510	46
4511	46
4511	120
4516	53
4518	40
4520	60
4543	120
4583	130

All above prices are NET and shown in pence

ANALOGUE

709C5	49
709C14	44
723C14	36
741C5	57
741C8	18
741C14	47
747C14	65
748C8	35
1458C5	62
1458C14	40
7106	450N
7107	500N
555	23
7555	86
556	45
CA3046	78
CA3080E	86
CA3130E	99
CA3140E	55
LM301AN	26
LM308N	60
LM317K	321
LM324N	45
LM348N	65
LM380N	75
LM380N8	104
LM381N	145
LM382N	115
LM3900N	50
LM3914N	200
LM3915N	200
NE555V	23
NE556A	45
NE567N	104
RC4151NB	80
S041E	290
S041P	121
S042E	364
S042P	138
S89	11.23
S178B	31.00
S187	13.28
S566B	214
S576A	235
S576B	235
S576C	235
S576D	225
S1469	468
SAB0600	302
SAB3209	497
SAB3210	311
SAB3211	168
SAB3271	329
SAB4209	497
SAB8256C	35.40
SAD1024	15.50
SAJ131	238
SAJ141	224
SAJ205	810
SAS231W	260
SAS251	142
SAS580	196
SAS590	196
SDA5680A	15.55
TAA761	104
TAA761A	49
TAA765A	62
TAA861	103
TAA865A	59
TAA2761A	72
TAA4761A	113
TAA4765A	120
TAB1041W	187
TBA120AS	62
TBA120U	72
TBA400	100N
TBA800	75
TBA10S	75
TBA820	75
TBB1458	62
TBB1458B	40
TCA105	120
TCA105B	108
TCA105G	140
TCA250A	185
TCA205K	200
TCA335A	66
TCA345A	109
TCA345W	177
TCA671	131
TCA780	211
TCA871	114
TCA955	228
TCA965	136
TCA965K	170
TCA971	92
TCA991	80
TCA991K	100
TDA2002	120
TDA2003	126
TDA2030	150
TDA4050B	144
TDA4290	169
TDA4600	184
TDA4700A	546
TDA4718A	435
TFA1001W	252
TL071CP	45
TL072CP	75
TL074CN	120
TL081CP	46
UAA170	165
UAA170L	152
UAA180	165
UAA190	141
XR2206	520
ZN414	85
ZN424P	99
ZN425E	350

CRYSTALS

(in MHz)

0.032768	102	4.433	128
0.100000	453	4.915	157
1.000	453	5.000	157
1.8432	320	5.026	128
2.000	268	6.000	157
2.4576	268	6.144	157
3.2768	188	6.5536	128
3.579	128	8.000	1.88
4.000	102	8.867	128
4.194	128	10.000	157
		18.432	188

THERMISTORS

K164

Disk type, 5mm dia Resistance at 20°C; 6R8, 10, 22, 47, 100, 220, 470, 1K, 2K2, 4K7, 10K, 22k, 47K, 100k each **18p**

LOUDSPEAKERS

1½" dia 8Ω	70
2½" dia 8Ω	70
2½" dia 64Ω	70

DIN AUDIO

Pins	plug	skt
2	8p	8p
3	14p	8p
4	15p	14p
5 (180°)	17p	11p
5 (240°)	20p-	
	8p	
6		
7	19p	30p

JACK PLUGS, SKTS

MONO 25"			
chrome P1	53p	34p	42p
plastic P2	32p	14p	20p
STEREO 25"			
chrome P3	81p		52p
plastic P4	60p	15p	20p
Mono 3.5mm	18p		14p
Stereo	23p		42p

D–SERIES

9	78p	104p	92p
15	106p	140p	96p
25	141p	205p	110p
37	199p	298p	122p

IDC Connectors

DIL

14 way	103p
16 way	117p
24 way	170p
40 way	265p

PARALLEL TYPE

	Plug	Skt
2 × 8 way	192	184
2 × 10 way	225	205
2 × 13 way	279	258
2 × 17 way	333	299
2 × 20	382	315

Plugs have retainers. Sockets have strain relief

MAINS TYPE

1 E C style, 6A 250V

Cable socket 43R01	69
Cable plug 42R04	95
Chassis socket 43R04	63
Chassis plug 43R02	45

BNC (up to 500MHz) 50Ω

Plug UG88U	80
Line skt. UG290U	75
Round skt. UG1094U	

UHF 50Ω

Plug PL259	42
Round socket S0239SH	35

UHF/UHF couplers

Plugs	83
Sockets	44

IC SOCKETS

pins	each	25 for
8	8p	1.60 N
14	12p	2.40 N
16	14p	2.80 N
18	16p	2.20 N
20	18p	3.60 N
22	21p	4.20 N
24	21p	4.20 N
28	22p	4.40 N
40	30p	6.00 N

TERMINALS

Plastic, screw, 15A several colours 24
S14 4mm socket 12
P14 4 mm plug 10
Wander plugs & sockets red/black only ea 14

PC Mounting terminal blocks 60am

2 way 17p, 4 way 33p, 6 way 49p, 8 way 66p, 10 way 82p, 12 way 98p

COAX (TV)

Plug 25
Line socket 48Socket 44

QUICK TEST

Mains connector – block, fused 525

CAPACITORS

Polystyrene, Siemens
5% Tolerance 160V
5, 7, 10, 12, 15, 18, 22, 27, 33, 39pF **15p;** 47, 56, 68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 560, 680, 820pF, 1n, 1n2, 1n5, 1n8, 2n2, 2n7, 3n3, 3n9, 4n7, **10p;** 5n6, 6n8, 8n2, 10n, **13p**
Ceramic Very small 1.8, 2.2, 2.7 etc, up to 1n **5p each.** 1n5, 2n2, 3n3, 4n7, 6n8, **5p;** 10n, 22n, **6p;** 33n, 47, **7p;** 100n, **8p**
Polyester, Siemens Layer Type 7.5mm lead spacing 100V
1n, 1n5, 2n2, 3n3m **6p;** 4n7, 6n8, 8n2, 10n 12n, 15n, 18n, 22n, 33n, 47n, **7p** 56n, 68n, **7p;** 82n, 100n, **9p** 120n, 150n, **15p;** 180n, 220n, **12p;** 270n, 330n, 330n, 390n, 470n, **15p;** 560n, 680n, **24p;** 10mm spacing 1uF **25p;** 15mm spacing 2ú2 **35p;** 22.5mm, spacing 1uF 400V **50p;** 3.33uF 100V **69p;** In depth stocks.

ELECTROLYTICS

1/63	10
2.2/25	13
2.2/63	10
4.7/63	11
4.7/100	14
6.8/40	10
10/6	13
10/25	10
10/40	11
10/63	14
10/100	15
22/10	10
22/25	11
22/40	14
22/63	15
22/100	16
47/3	03
47/10	11
47/25	12
47/40	15
47/63	17
47/100	18
100/3	03
100/10	13
100/16	14
100/25	15
100/40	15
100/63	20
100/100	27
220/10	16
220/16	16
220/25	18
220/40	20
220/28	28
220/100	42
470/10	19
470/16	19
470/25	19
470/40	27
470/63	45
470/100	73
1000/10	19
1000/16	26
1000/25	36
1000/40	44
1000/63	76
2200/6	09
2200/16	44
2200/25	
2200/40	73
4700/16	72
4700/25	90

TANTALUM BEARS

0.1/35	13
0.22/35	13
0.47/35	13
1.0/35	13
2.2/16	13
2.2/35	16
4.7/16	16
4.7/35	18
6.8/16	16
6.8/25	24
10/6.3	16
10/16	18
10/25	18
22/6.3	18
22/16	30
22/25	30
33/6.3	24
33/10	30
47/6.3	30
100/10	80

For full ranges of very many other types please see Cat 82 and/or current price list.

BOXES

High quality Black ABS plastic or die-cast plain or stove grey.

L	W	D	ABS		Plain		Stove Gr	
50	50	25	–		5001P	90p	5001	123p
100	60	25	2002	96p	5002P	117p	5002	154p
113	63	31	2003	109p	5003P	143p	5003	184p
121	66	40	2004	115p	5004P	162p	5004	210p
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2N930	20
2N1132	23
2N1302	110
2N1303	58
2N1304	62
2N1305	62
2N1306	90
2N1307	67
2N1308	147
2N1309	99
2N1599	100
2N1613	25
2N1711	25
2N1893	32
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2N2219A	25
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2N2484	25
2N2646	45
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2N3054	55
2N3055	48
2N3405	64
2N3663	15
3702-11	09
2N3771	180
2N3794	21
2N3819	22
2N3820	40
3823	60N
2N3904	15
2N3906	15
2N4036	46
2N4058-62	09
2N4124	25
2N4126	25
2N4284	30
2N4286	18
2N4289	23
2N4291	24
2N4292	21
2N4991	62
2N5062	32
2N5192	110
2N5195	106
2N5457	32
2N5458	32
2N5459	36
2N6050	380
2N6057	375
6F40	152
16F40	165
40HF40	225
40361DIS	
40362	65
40406	71
40408	95
40412	108
40430	100
40594	123
40595	123
40636	147
40673	145
A9903	16
AA113	13
AA116	13
AA117	13
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AA119	13
AC126	25
AC127	25
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BC160	30
BC161	30
BC167A	09
BC167B	09
BC168A	09
BC168B	09
BC169B	09
BC169C	09
BC177B	16
BC178B	16
BC179B	18
BC182	09
BC182L	09
BC183	09
BC183L	09
BC184	09
BC184L	09
BC202Y	120
BC212	09
BC212L	09
BC213	09
BC213L	09
BC214	09
BC214L	09
BC238C	09
BC239C	09
BC258B	09
BC267B	16
BC300	26
BC301	24
BC303	30
BC327	16
BC328	11
BC337	14
BC338	11
BC413	09
BC414	09
BC477	29
BC546	10
BC547	09
BC548	09
BC549	09
BC550	10
BC556	10
BC557	09
BC558	09
BC559	09
BC560	10
BC879	38
BC880	43
BCY31A	157
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BD130	45N
BD131	48
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BD135	27
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BD644	42N
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C0340	490N4
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C0546	126N1
C762	40
C1406	77
D4 clip	for
C1406	and
E2506	10
D1046	88
E1110	76
E1210	76
E2506	154
EB383	20
MJ2955	90
MJE340	55
MJE2955	95
MJE3055	70
MPF102	40
MPS6531	40
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MPSA63	38
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OA47	12
OA90	10
OA91	10
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OA202	14
OC28	75
OC29	75
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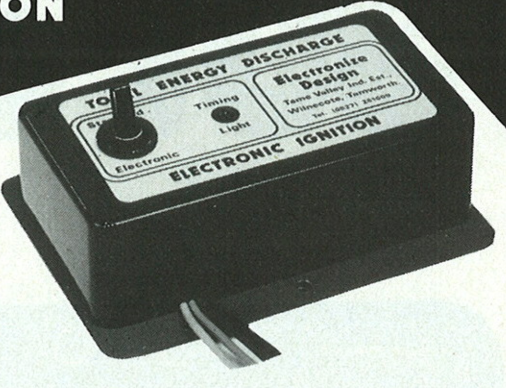

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The basic function of a spark ignition system is often lost among claims for longer "burn times" and other marketing fantasies. It is only necessary to consider that, even in a small engine, the burning fuel releases over 5000 times the energy of the spark, to realise that the spark is only a trigger for the combustion. Once the fuel is ignited the spark is insignificant and has no effect on the rate of combustion. The essential function of the spark is to start that combustion as quickly as possible and that requires a high power spark.

The traditional capacitive discharge system has this high power spark but, due to it's very short spark duration and consequential low spark energy, is incompatible with the weak air/fuel mixtures used in modern cars. Because of this most manufacturers have abandoned capacitive discharge in favour of the cheaper inductive system with it's low power but very long duration spark which guarantees that sooner or later the fuel will ignite. However, a spark lasting 2000µS at 2000 rev/min. spans 24 degrees and 'later' could mean the actual fuel ignition point is retarded by this amount.

The solution is a very high power, medium duration, spark generated by the TOTAL ENERGY DISCHARGE system. This gives ignition of the weakest mixtures with the minimum of timing delay and variation for a smooth efficient engine.

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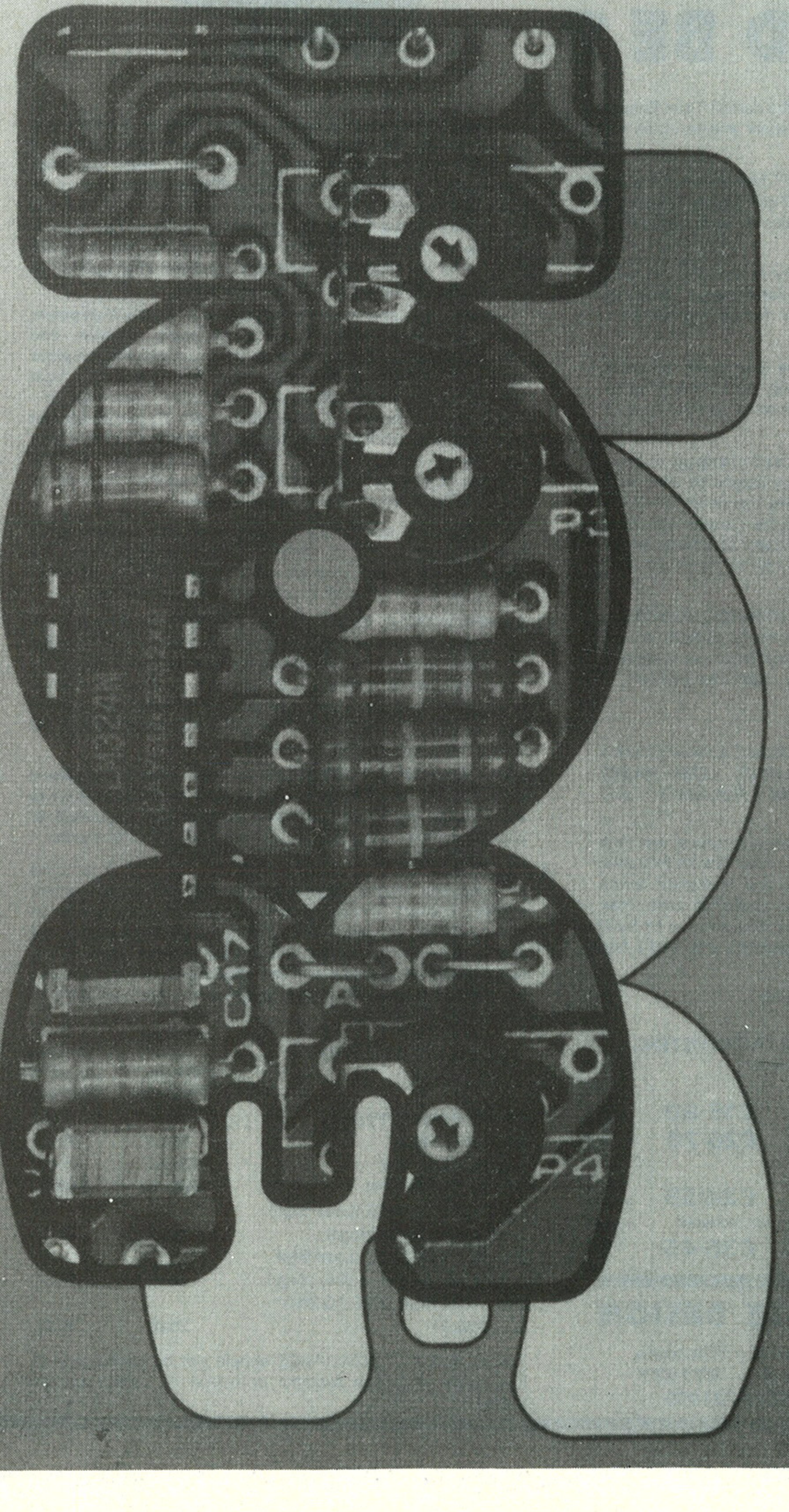
- ★ **PRECISION SPARK TIMING CIRCUIT** This circuit removes all unwanted signals caused by contact volt drop, contact shuffle, contact bounce, and external transients which, in many designs, can cause timing errors or damaging un-timed sparks. Only at the correct and precise contact opening is a spark produced. Contact wear is almost eliminated by reducing the contact breaker current to a low level - just sufficient to keep the contacts clean.

TYPICAL SPECIFICATION	Total Energy Discharge	Ordinary Capacitive Discharge
SPARK POWER (Peak)	140W	90W
SPARK ENERGY	36mJ	10mJ
STORED ENERGY	135mJ	65mJ
SPARK DURATION	500µS	160µS
OUTPUT VOLTAGE (Load 50pF, equivalent to clean plugs)	38kV	26kV
OUTPUT VOLTAGE (Load 50pF + 500k, equivalent to dirty plugs)	26kV	17kV
VOLTAGE RISE TIME TO 20kV (Load 50pF)	25µS	30µS

TOTAL ENERGY DISCHARGE should not be confused with low power inductive systems or hybrid so called reactive systems.

301 circuits



The book follows the theme, and is a continuation of our popular and very successful 300 circuits publication. It is composed of 301 assorted circuits ranging from the simple to the more complex designs described and explained in straightforward language. An ideal basis for constructional projects and a comprehensive source of ideas for anyone interested in electronics. In a nutshell something to please everybody.

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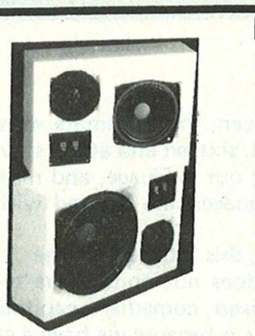

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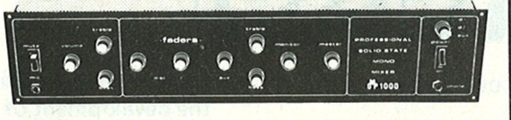

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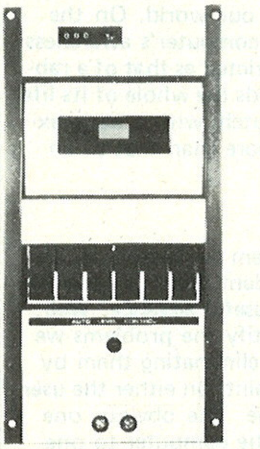

6 piano type keys

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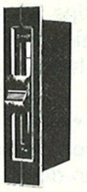

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12" 100 watt R.M.S. Impedance 8 ohm, 50 oz magnet. 2" aluminium voice coil. Resonant Frequency 25Hz. Frequency Response to 4KHz. Sensitivity 95dB. **Price £23.70 each.** £3.00 Packing and Carriage each.

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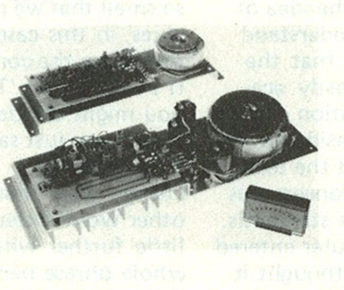
POWER AMPLIFIER MODULES



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310 watts R.M.S. (OMP 300)
Loads: Open and short circuit proof. 4-16 ohms.
Frequency Response: 20Hz – 25KHz ±3dB.
Sensitivity for Max. Output:
500mV at 10K (OMP 100) 1V at 10K (OMP 300)
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Supply: 240V 50Hz
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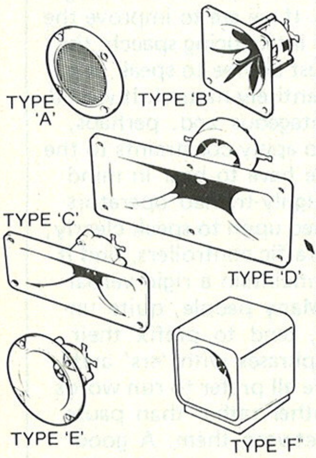

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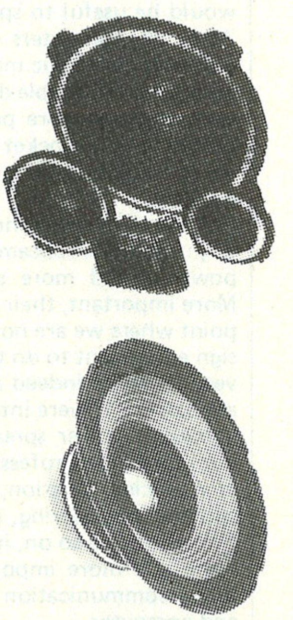

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Talking to computers

by Brian Pay, National Physical Laboratory, London

Speech is the quickest and most natural form of human communication. So, the best way of improving our interface with computers and other machines, to get the utmost from the microcomputer power now available to us, is to develop systems that recognise natural, continuous speech without need for special enunciation or unnatural pauses between words. Through research at the UK National Physical Laboratory, we may expect to see such systems appear within the next few years.

For more than 50 years scientists have been fascinated by the idea of getting a machine to understand speech. We may assume that the interest was, at first, mostly academic, because no application of such a device was seriously considered. We can also certainly say that the technology available to the pioneers was very primitive by today's standards. So, when the word computer entered our vocabulary, nobody thought it would be useful to speak to one. After all, computers were gigantic pieces of electronic machinery, some as big as 10 double-decker buses, with scarcely more power than a programmable pocket calculator that we can now buy for a little less than £100.

But the technology moved very rapidly: computers became smaller, more powerful and more sophisticated. More important, their cost fell to the point where we are now able to design equipment to do tasks that are very complex indeed and to behave almost as if it were intelligent. With computer power spreading accross disciplines and professions as diverse as medicine, aviation, banking, insurance, engineering, police work, education and so on, it has become more and more important to improve communication between man and computer.

We could see this need arising in the late 1950s and the early 1960s, with the introduction of so-called high-level programming languages that were nevertheless simple to use and the development of machines to recognise the type-written word. A decade later there was a surge in research into speech recognition. Today, the general belief is that it will have to be as commonplace to talk to a computer as it is to make a telephone call if we are to get the best from the microcomputer power now at our finger-tips. The problem is no longer academic; the rewards for success will be high.

Flow of words

Why then, with all the research that has been done, has the problem not been solved? To answer this question it is probably best to reason 'from the top down'. Let us consider a task that seems quite trivial but is really extraordinarily difficult, such as simply dictating a letter to a speech-driven typewriter. If I were to say to you 'Catalogue four feet long', you would think it nonsense. But imagine, if you will, that you are a tree-feller being instructed by foreman: you would probably hear me say 'Cut a log four feet long'. The acoustic difference between the two phrases is so small that we must rely on other clues, in this case our environment, to discern the correct meaning.

If I were to say 'There were six . . . ' you might decide, at that instant, that I have just said the word six. But if I continue ' . . . teen . . . ' you change your first decision to the other word sixteen. If I continue a little further with ' . . . agers ' the whole phrase becomes 'There were six teenagers' and you realise that your first guess, the word six, was correct.

Yet another example is a news item on the radio: 'The Government is considering attacks on merchant shipping'. This might well have been true in 1940; but was not the news-reader really saying 'The Government is considering a tax on merchant shipping?

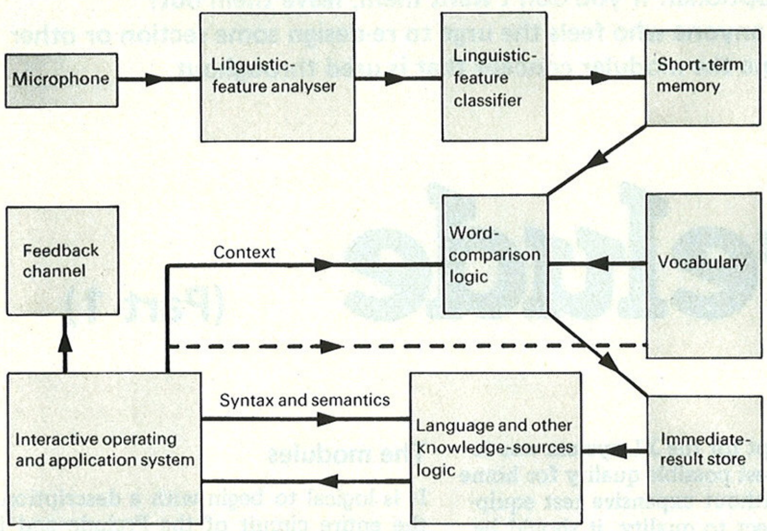
From these examples we can make fundamental observations. First, there is no correlation between pronunciation and the way words are spelt. Second, spoken words flow into each other, whereas in written language there are convenient spaces between them. Third, we cannot extract meaning from a message without using a great many clues: in one case, our environment; in the next, subject matter or context and, in yet another case, the state of international affairs. Fourth, and most important, every legitimate word in our language is likely to appear as a 'rogue'. In the examples already given, the legitimate words (catalogue, sixteen and attacks) were all rogues; our language, and most other languages, are littered with them.

In general, this attribute of the language does not confuse us too much (indeed, comedians capitalise on it). This is because we have a wide knowledge of our world. On the other hand, a computer's awareness may be as restricted as that of a rabbit which spends the whole of its life in the same hutch, with a basic experience no more than that of an infant.

Specific task

So it would seem our secretaries are not yet redundant. But is it possible to make any useful advance? Well, when we identify the problems we can set about eliminating them by placing constraints on either the user or the machine. The obvious one is to rectrict the computer to one specific task, such as explicit collection of data, which may have to do with, for example, temperature readings, contour data in map reading, and so on. The job may be to acquire information from a data bank, perhaps covering warehouse stocks, social security records, train or aircraft time-tables and movements; or it may cover heuristic applications, in which problems are tackled by trial and error, of the sort often found in banking, insurance, police work and medicine. Alternatively, the application may be in the control of a system where, as often as not, the operator's hands are already fully occupied: one such example is control of an aircraft.

None of these applications depends upon the direct use of speech, but in general they all depend upon the supply of certain special knowledge or expertise. If we are to improve the interface by introducing speech, the operator must be free to speak in a way that is entirely natural. It would be disadvantageous and, perhaps, dangerous to apply constraints to the user, and we have to bear in mind that even highly-trained operators who are called upon to speak clearly, such as air traffic controllers, find it difficult to maintain a rigid verbal discipline. Many people, quite unconsciously, tend to prefix their words and phrases with 'ers' and 'ums' and we all prefer to run words into each other rather than pause distinctly between them. A good example is the way we pronounce numerals: try saying your telephone number with a well-defined pause between each digit.


Microphone
Linguistic-feature analyser
Linguistic-feature classifier
Short-term memory
Feedback channel
Context
Word-comparison logic
Vocabulary
Syntax and semantics
Interactive operating and application system
Language and other knowledge-sources logic
Immediate-result store

Block diagram of the NPL speech-recognition system. Its heart is the block at the lower left, the only module that needs to be chosen according to the application. It issues directives to the rest of the system, digests incoming information and controls the information fed to the user via the feedback channel. It needs to be completely 'aware' of what is important, and how important, in the specific application. The linguistic feature analyser extracts from the speech only the important content, disregarding irrelevant characteristics such as whether the voice is male or female, or whether the speaker has a head cold. The signal is then classified into linguistic features which are stored in the short-term memory (STM). A word-comparison logic module compares features in the STM with words in the vocabulary and stores possible and probable results in the intermediate-result store; this logic is controlled by the application system, which decides which words need be compared, thereby removing a large amount of ambiguity. Fundamental language rules (for example, how words can flow together) are applied to the signal from the immediate-result store by the next module, which also applies rules explicity to do with the application (supplied by the application system); the processed information is finally fed back to the system. The context channel fixes which words in the vocabulary module are relevant: for example, in 'what day of the week is it?' the context has determined that only the names of days matter. Syntax information governs the form the operator is expected to use and leaves the system aware only of the base syntax: for example, 'shut door' is the artificial syntax of, say, 'please shut the door'. Semantics information relates directly to meaning within the application: '429 degrees' is, for example, meaningless as a compass bearing, and 'a person with grey hair and balding' cannot be 'sixteen'. (People use may clues to apply semantics). The application system is, of course, the computer itself.

Speech algorithms

To aggravate the problem, it is by no means certain that all the users of a system would realise that there were constraints imposed and, if so, precisely what they were. This makes for a very low integrity of interface. It is to this aspect of the speech recognition problem that we have directed most effort.

So, while other researchers have applied constraints to the user in various degrees, we have been firmly of the opinion that constraints other than natural ones always create other problems. Having adopted that approach, we have built up many years of experience and we are now able to use speech naturally by employing what we call continuous speech algorithms. This term may perhaps be too simple a description, for the design of the algorithms, which are prescribed steps in computer processing of the input data, takes into account a great deal of information about the way the language is constructed and how it is spoken. One important thing that has to be taken into account is the enormous amount of acoustic data that we emit whenever we speak, so we have to know how the language is constructed if we are to eliminate all those data that are not essential. It means that we have to know the language's phonetic decoding rules and those that govern the way it is ordered.

Obviously, the sounds we make depend on our vocal mechanism. Because we all have similar mechanisms, the basic amount of data we produce is independent of whatever our native language might be. We call the sounds we make 'linguistic features' and they become encoded into the language we speak. Once we can capture and identify them, the subsequent part of the speech recognition process is, of course, peculiar to that language.

Written language and their alphabets are interesting, too, in the context of our problem. Both the Cyrillic alphabet, used by certain Slav people and by the Russions, and the socalled English Initial Teaching Alphabet (ITA) contain about 40 symbols and are phonetic, each symbol being known as a phoneme and representing a spoken sound. The definition of a phoneme is 'a unit of significant sound in a given language', but a more precise definition would be 'a unit of sound, within a word, that would, if replaced or removed, change the meaning of the word.

Context

It is a remarkable coincidence that all languages use about 40 phonemes; there is no obvious reason why. Nevertheless, the foregoing definitions show that the phoneme is a symbol of information that cannot be independent of the language. In other words, no phoneme can be defined without stating the language to which it belongs. As with words, which are obviously language-dependent, there is no convenient way of telling where one phoneme ends and the next one begins in natural, flowing speech. Speech has, indeed, more in common with handwriting than with printed text, for the printed words have clear spaces between them. But in handwriting, individual characters are often difficult, and even impossible, to identify when its companions on both sides are covered from view. Indeed, handwriting and speech are fully understood only because we bring other clues into play, the most important being that of context. It appears that language evolves through certain contextual rules by which we need articulate fully only those words or parts of words that carry the more important information. For example, you would understand someone to say 'Please shut the door' even if the word 'the' were not said at all. It is quite usual for there to be only a slight acoustic disturbance between 'shut' and 'door'. Nevertheless, we may expect to see speech-recognition systems appear, within the next few years, which will respond to our talking to them in a completely natural way. When that comes about, we shall be a great deal nearer to the ideal, 'friendly' computer interface.

(8435 S)

It is impossible to design a perfect preamplifier – one that will suit everyone's taste. But there's no harm in trying! For our XL system, we felt that the best was just good enough. We didn't skimp on components, and we included almost every feature we could think of. At the same time, all the 'features' are optional: if you don't want them, leave them out! Furthermore, anyone who feels the urge to re-design some section or other should welcome the modular concept that is used throughout.

Prelude (Part 1)

the preamplifier of the Elektor XL system

Our basic concept for the XL system was to achieve the highest possible quality for home construction, without expensive test equipment. With respect to quality, it should be noted that most of the modules in the XL system contain considerably more components than is usually the case in projects for home construction. The Prelude is no exception. However, one should not be discouraged by the large number of components; construction is facilitated by a detailed description and modular design. Furthermore, the circuit is designed so that Prelude can be configured according to one's personal desires. Any sections considered to be superfluous can be omitted.

Since the Prelude preamplifier is a fairly involved project for home construction, we have had to subdivide the entire description into several chapters. In this issue we will begin with the description of the entire circuit using a block diagram, with the power supply, the connecting board and the headphone amplifier. The latter will be assigned an article of its own, because it is also very suitable for applications in or with other preamplifiers.

The modules

It is logical to begin with a description of the entire circuit of the Prelude and its operations in general. Clearly, the most important task for a preamplifier is to provide sufficient signal amplification without distortion. Furthermore, the user must have the facility to select various signal sources and match their levels. This particularly applies to pick-ups. In the hi-fi world in recent years there has been a growing trend to omit everything that is not absolutely necessary. The argument is that unnecessary equipment can only contribute to distortion and/or noise. Without challenging this statement, it is nevertheless true to say that there are also hi-fi enthusiasts who expect their preamplifiers to be suitable for various tape units, to provide wide tone adjustments, and so on. There are no objections to this approach, as long as the quality is not impaired and all "extras" in the signal path can be bypassed. This is the case with the Prelude. It will meet practically all requirements. In constructing this preamplifier, modules that are considered to be necessary can be incorporated

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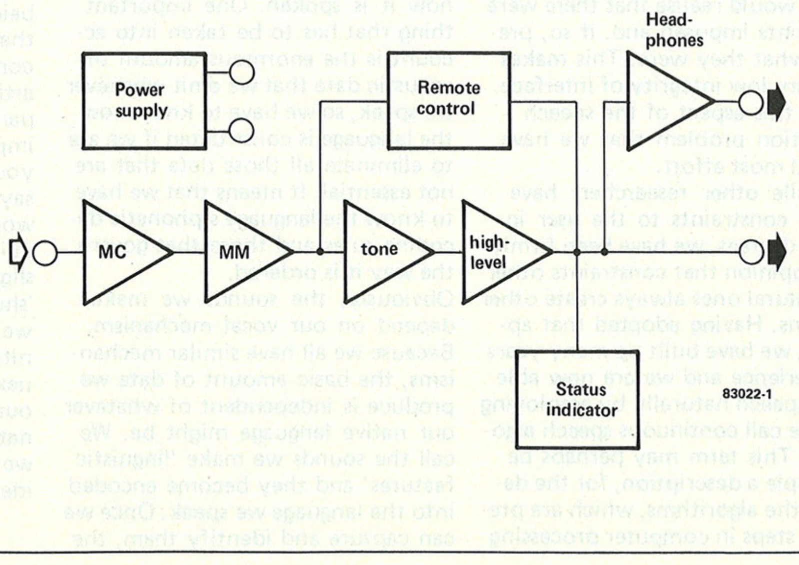

Figure 1. The block diagram of the Prelude preamplifier shows the operational blocks of the completed unit. The "bare minimum" is the MM preamplifier, high-level ("line") amplifier and the power supply.

2

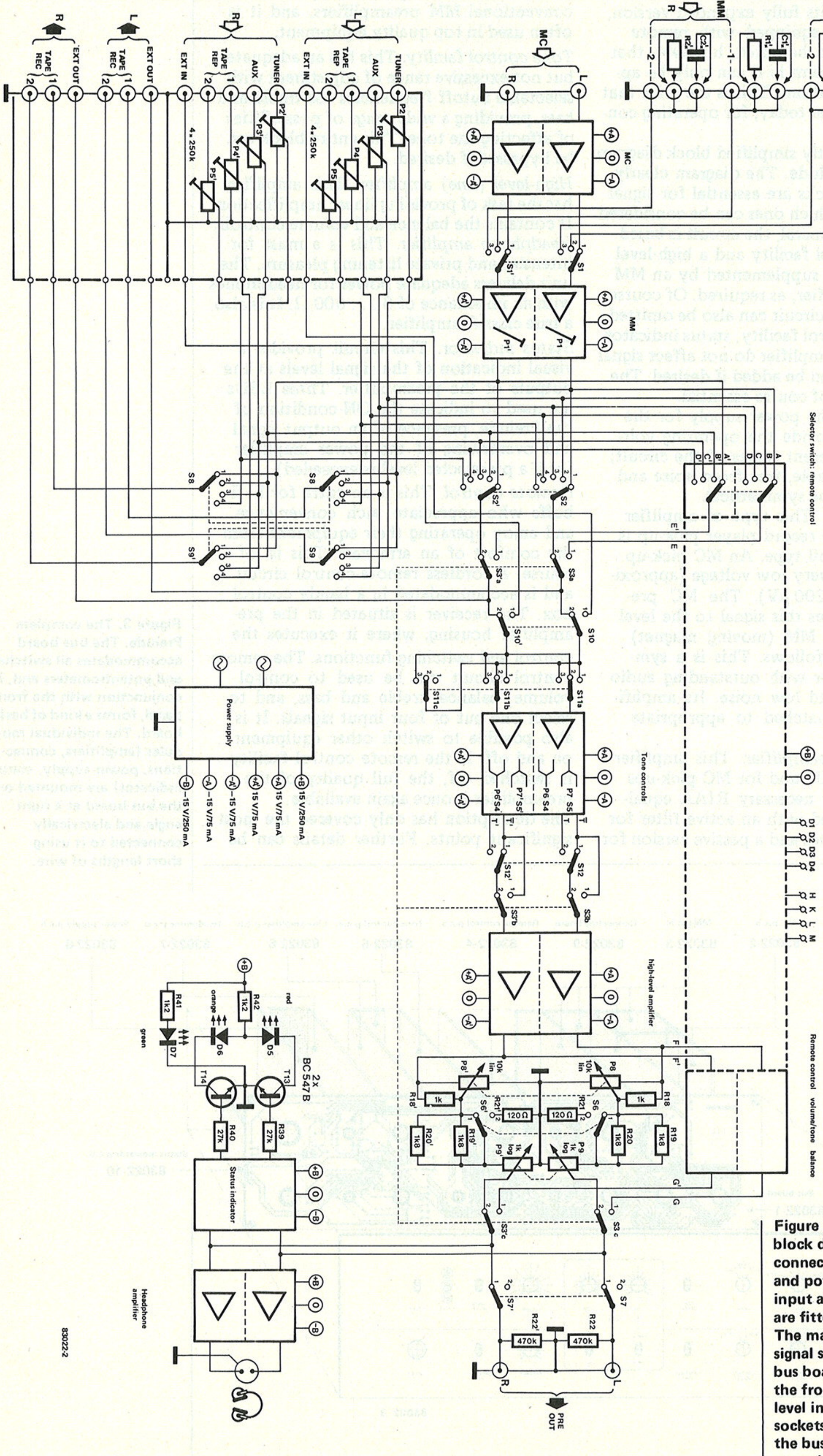

Figure 2. The extended block diagram contains all connecting leads, switches and potentiometers. The input and output sockets are fitted to socket boards. The many conductors for signal switching are on a bus board situated behind the front panel. The high-level input and output sockets are connected to the bus board by means of a special connecting board.

and the others can be omitted. It is therefore just as possible to construct a basic preamplifier. In its fully expanded version, Prelude is even equipped with remote control. It should be noted, however, that in this case the term hi-fi can only be applied with reservations. This is the price that must be paid, even today, for operating convenience.

Figure 1 is a greatly simplified block diagram of the entire Prelude. The diagram clearly shows which blocks are essential for signal processing and which ones can be considered as "extras". In general, the circuit is based on a tone control facility and a high-level "line" amplifier, supplemented by an MM and/or MC amplifier, as required. Of course, the tone control circuit can also be omitted. The remote control facility, status indicator and headphone amplifier do not affect signal processing and can be added if desired. The power supply is of course essential.

Power supply. The power supply for the Prelude must provide the operating voltages for the different stages of the circuit; these must be stable, free from noise and ripple and must be symmetrical.

MC preamplifier. This type of amplifier is required if the record player pick-up is of the moving coil type. An MC pick-up only provides a very low voltage (approximately 100 . . . 200 µV). The MC preamplifier amplifies this signal to the level required by the MM (moving magnet) amplifier which follows. This is a symmetrical amplifier with outstanding audio characteristics and low noise. Its amplification can be matched to appropriate pick-ups.

MM (or MD) preamplifier. This amplifier is required for MM and for MC pick-ups (see above). The necessary RIAA equalisation is obtained with an active filter for the low frequencies and a passive version for the high frequencies. This circuit principle offers some advantages in comparison with conventional MM preamplifiers, and it is often used in top quality equipment.

Tone control facility. This has an adequate but not excessive range of adjustment with selectable cutoff frequencies for treble and bass, providing a wide range of possibilities of affecting the tone. This entire block can be bypassed if desired.

High-level (line) amplifier. This amplifier has the task of providing linear amplification. It contains the balance and volume controls.

Headphone amplifier. This is a must for intensive and private listening pleasure. The unit delivers adequate power for headphones with an impedance of 8 . . . 600 Ω. It is also a true class A amplifier.

Status indicator. This circuit provides a visual indication of the signal levels at the outputs of the preamplifier. Three LEDs are used to indicate the ON-condition of the Prelude, presence of an output signal and overdriving of the power amplifier (or if a preselected level is exceeded).

Remote control. This is an extra for hi-fi buffs who appreciate such convenience and enjoy operating their equipment from the comfort of an armchair. This is, of course, a cordless remote-control circuit and is accommodated in a handy control box. The receiver is situated in the preamplifier housing, where it executes the control and switching functions. The remote control circuit can be used to control volume, balance, treble and bass, and to select one out of four input signals. It is also possible to switch other equipment on and off. If the remote control facility is switched off, the full quality of the preamplifier is once again available.

The description has only covered the most significant points. Further details can be

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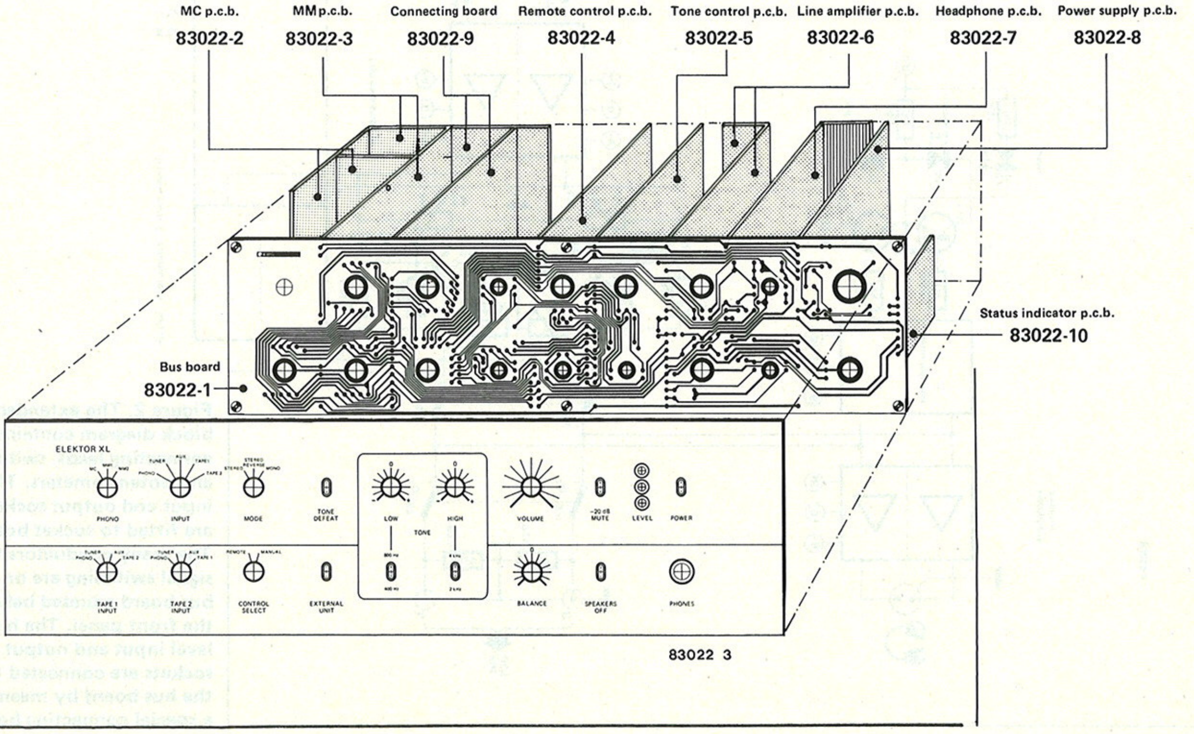


Figure 3. The complete Prelude. The bus board accommodates all switches and potentiometers and, in conjunction with the front panel, forms a kind of basic board. The individual modules (amplifiers, connections, power supply, status indicator) are mounted on the bus board at a right angle and electrically connected to it using short lengths of wire.

4

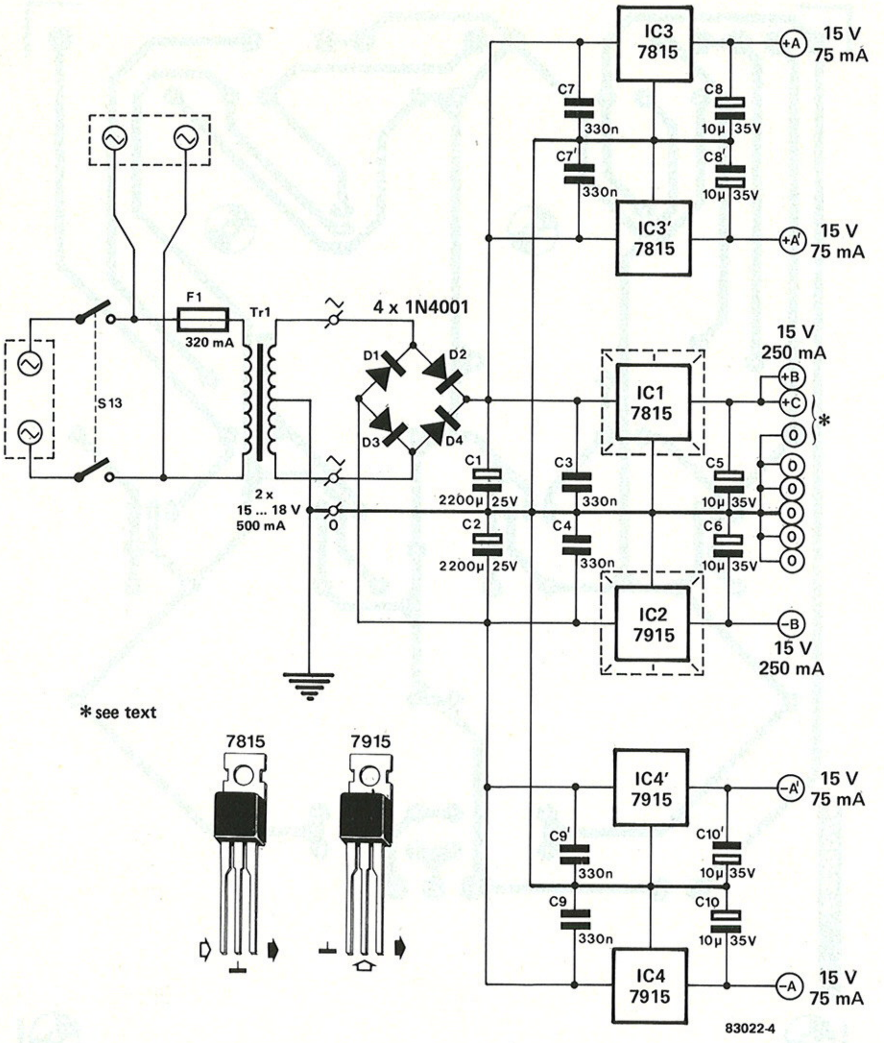
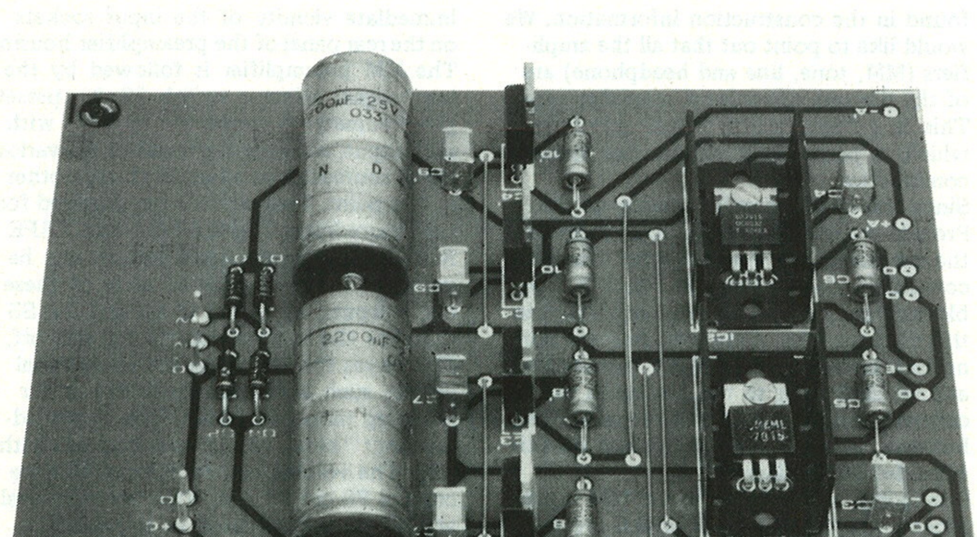


Figure 4. The power supply circuit of the Prelude. In order to provide the greatest possible rejection of crosstalk between the left and right channels, each channel is provided with its own power supply. There is also a 'power' circuit for the headphone amplifier, status indicator and remote control.



The advantage of IC voltage regulators is obvious: how else could you mount three complete symmetrical power supplies on a single p.c. board? Note the small heatsinks for IC1 and IC2.

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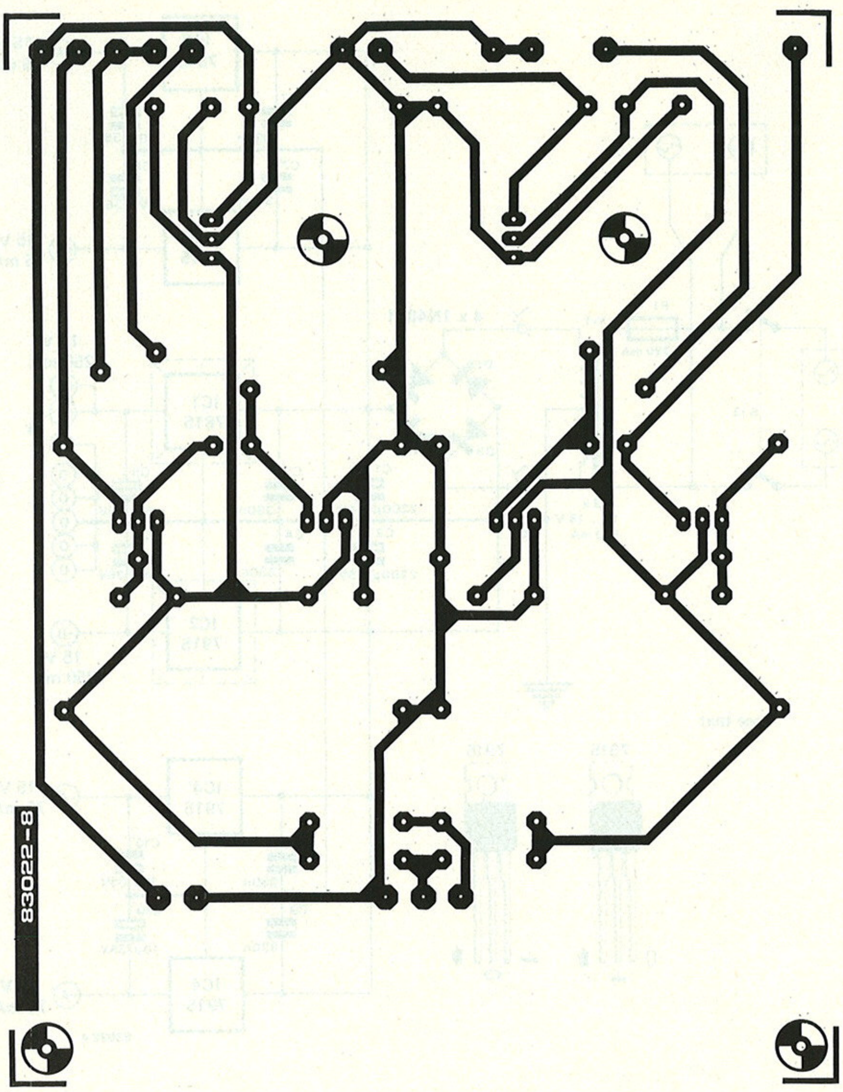


Figure 5. Track pattern and component layout for the power supply printed circuit board. IC1 and IC2 are fitted with small heat-sinks. Outputs A and B should be connected to the corresponding terminals on the bus board.

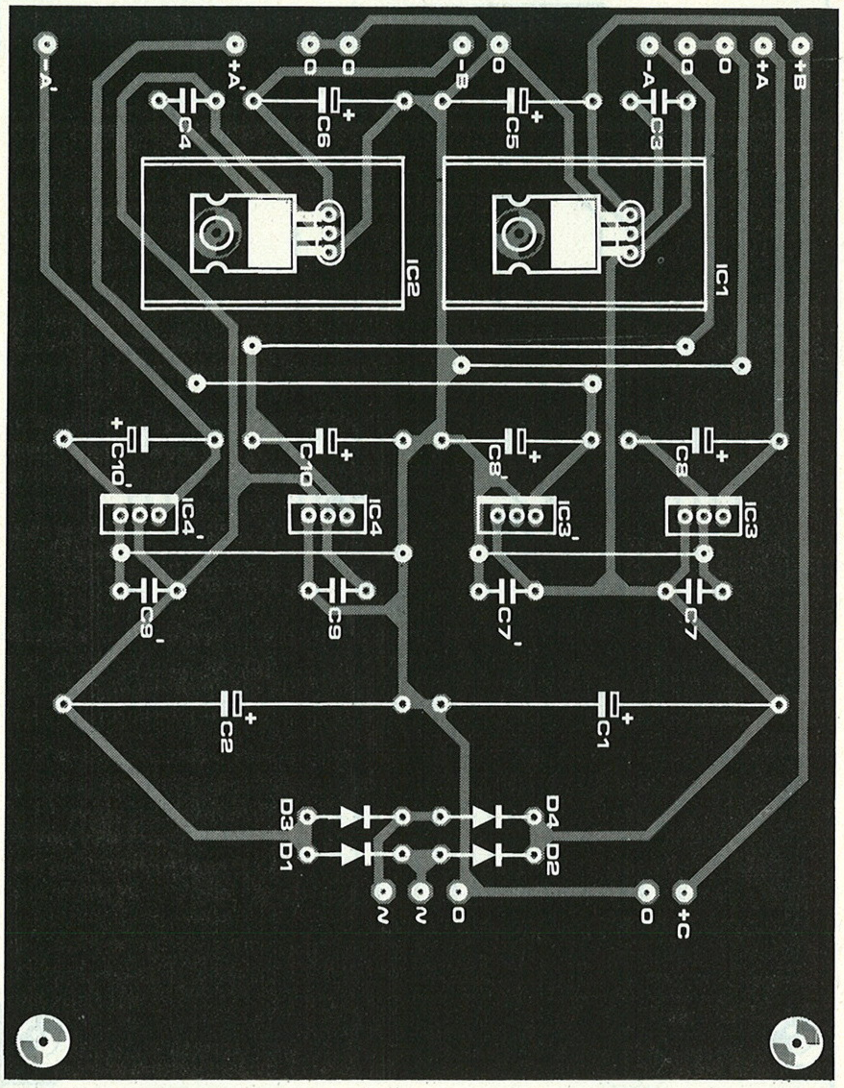
found in the construction information. We would like to point out that all the amplifiers (MM, tone, line and headphone) are of the discrete operational amplifier type. This is a high-quality circuit principle which is particularly reliable for home construction.

Since the entire circuit diagram of the Prelude would fill three or four pages of the magazine, we are providing a more convenient compromise in figure 2. The blocks from figure 1 were incorporated in this diagram. The many switches and connecting leads are particularly noticeable, and we shall refer to these again in the construction details for the Prelude. First, however, here are some comments on this extended block diagram.

Connected in parallel with the MM input sockets are other sockets which are intended to accept "adapter plugs". These plugs contain a resistor or a capacitor which, when combined with the impedance of the pick-up, form a suitable input impedance for the MM preamplifier. Switch S1 is used to select MC, MM1 or MM2. Since the signals applied to this switch are of a very low level, it is situated in the immediate vicinity of the input sockets on the rear panel of the preamplifier housing. The MM preamplifier is followed by the input-signal selector switch S2. A preset potentiometer is connected in series with each input, allowing the levels of the various signal sources to be adjusted to each other at this point. Two outputs are provided for tape recordings: TAPE REC 1 and TAPE REC 2. The various signal sources can be switched independently to each of these two outputs, by means of S8 and S9. S3 switches the remote control on and off. S10 serves for "patching in" an external device, such as an equaliser. S11 is for selecting mono or stereo. The "tone adjustment" block can be switched off with S12. The volume control P9 and balance control P8 are located after the high-level amplifier. Also situated at this point is switch S6 for attenuation of the output signal by 20 dB (MUTE). S7 allows the output signal to be disconnected from the power amplifier, to allow listening with headphones only.

The circuit in practice

Point-to-point wiring in a preamplifier



Parts list
for figure 5

Capacitors:
C1,C2 = 2200 µ/25 V
C3,C4,C7,C7',
C9,C9' = 330 n
C5,C6,C8,C8',
C10,C10' = 10 µ/35 V

Semiconductors:
D1 . . . D4 = 1N4001
IC1,IC3,IC3' = 7815
IC2,IC4,IC4' = 7915

Miscellaneous:
Tr1 = mains transformer
2x15 . . . 18 V/0,5 A sec.
2 heatsinks for
IC1 and IC2 (SK 13)
S13 = double-pole
mains switch

containing this number of switches and potentiometers would tend to encourage faulty connections. For this reason we have developed a bus board whose tracks represent almost all the connecting leads shown in figure 2. This bus board also serves as a mouting board for all the switches and potentiometers. The preamplifier is constructed in modular fashion. This means that each block in figure 2 is constructed on a separate printed circuit board. The different modules are connected with the bus board.

Figure 3 clearly shows the assembly of the different printed circuit boards for the Prelude. A special connecting board provides the connections between the input sockets at the rear and the bus board behind the front panel. As with the connecting board, some of the module boards are fitted with smaller boards to accept the corresponding sockets. As can be seen, every effort has been made to reduce the amount of wiring.

This modular design makes it possible, for example, to omit the MC board, the remote control board, the headphone board or the status indicator board. In this case, it is

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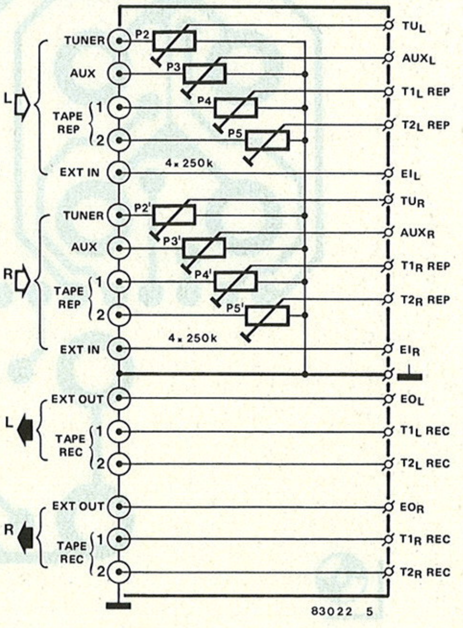

Figure 6. The "circuit" of the connecting board merely consists of 8 preset potentiometers and 16 input and output sockets. The leads are wired from the bus board behind the front panel to the sockets at the rear.

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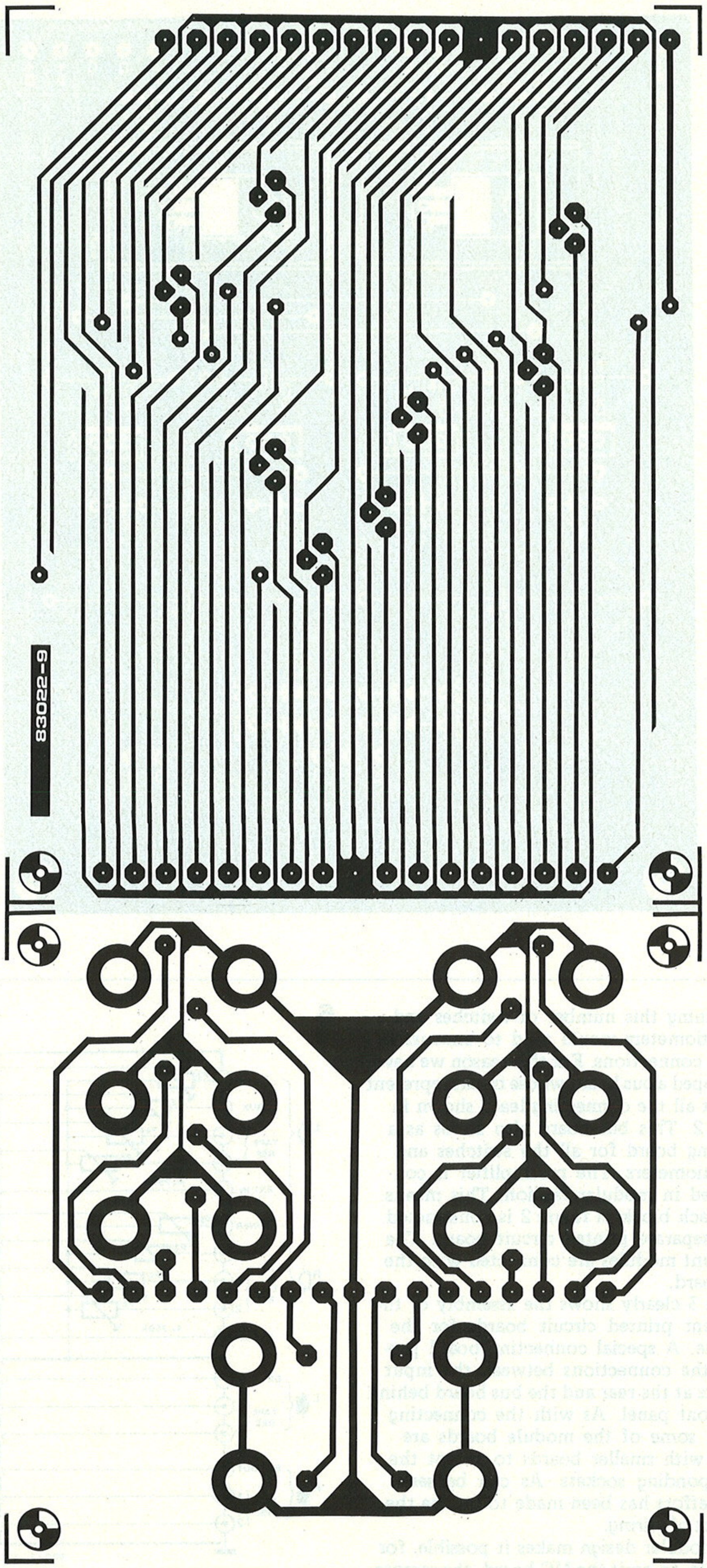
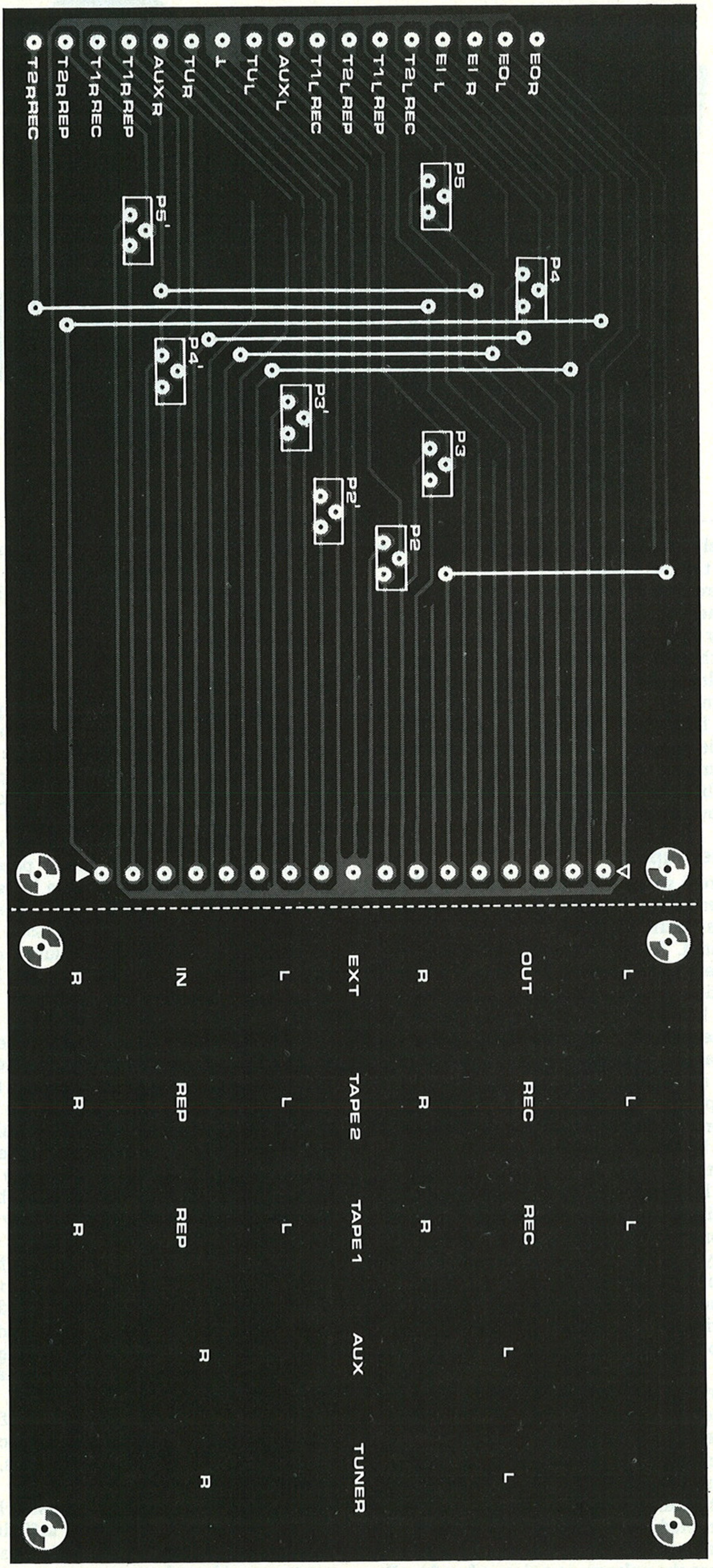


Figure 7. Track pattern and component layout of the connecting board. This consists of two parts which must be separated: the socket board and the actual connecting board with the preset potentiometers. Interconnect the terminals with the same designations.

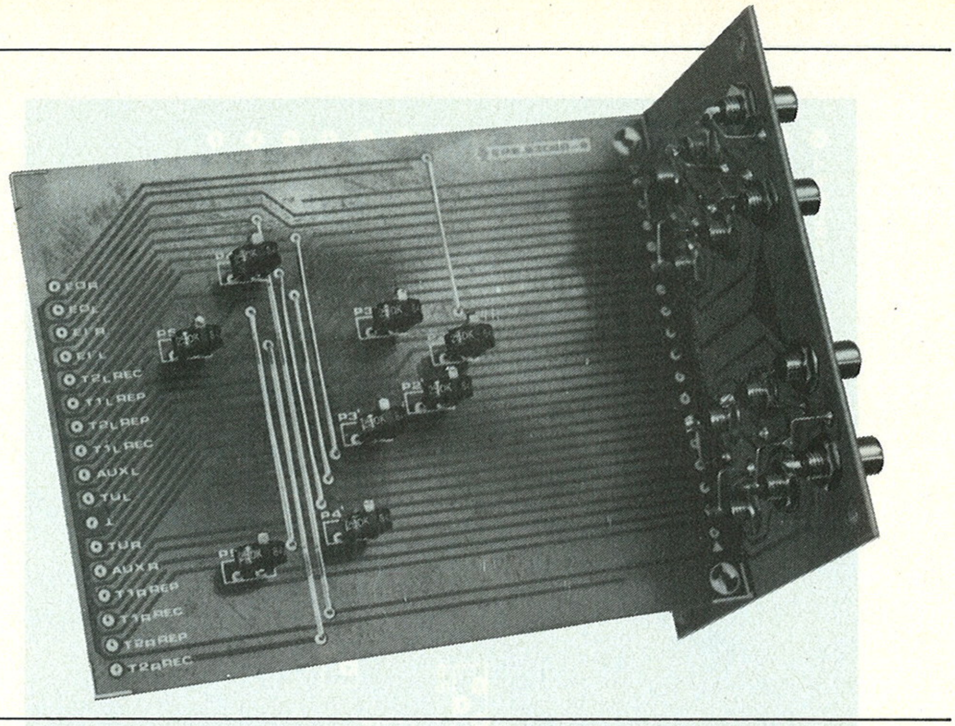


Note that it is advisable to use vertical mounting preset potentiometers.

Parts list for figure 7

Resistors:
P2 . . . P5,P2' . . . P5' = 220 k preset potentiometer

Miscellaneous:
16 Cinch sockets with screw mounting (metal)



One good photo explains more than a thousand words, when it comes to such a complicated mechanical construction as this connecting board!

merely necessary to insert a few wire links into the bus board.

Figure 3 also shows that a total of 10 boards are needed for the full circuitry. This is a fairly involved project and the description has therefore been distributed over several articles in Elektor. This month we will be dealing with the power supply, the connecting board and headphone board. This article contains the descriptions and track patterns for the power supply and connecting boards. The headphone amplifier will be covered by a separate article.

Power supply

Figure 4 shows the circuit diagram of the power supply. Six integrated voltage regulators ensure stability of the d.c. voltages required. In fact only two voltages are needed: +15 V and −15 V. It is good design practice, however, to separate light loads from heavy loads. For this reason, the headphone amplifier, remote control and status indicator are powered by IC1 and IC2. These lines are marked +B and −B. Since the headphone amplifier draws considerable current in class A operation, IC1 and IC2 must be fitted with heatsinks.

All stages involved in signal processing (MC, MM, tone and line) have two separate stabilising circuits, one for the left channel and one for the right channel. IC3 and IC4 supply the symmetrical operating voltage for the left channel and IC3' and IC4' are assigned to the right channel. Capacitors are wired in the vicinity of the regulator ICs to suppress possible interference at that stage. The other components, mains switch S13, mains transformer, bridge rectifier and electrolytic capacitors C1 and C2 require no special commentary.

The circuit is constructed on the board shown in figure 5. IC1 and IC2 are fitted with heatsinks. Once the circuit has been constructed and inspected, the power supply can be tested. Connect the transformer and measure the voltages at points +A, +A', +B (these are +15 V) and −A, −A', −B (these are −15 V), against ground. Perform a load test using 68 Ω/5 W resistors for + and − B and 220 Ω/1 W resistors for ±A and ±A'. This printed circuit board can now be put to one side and components can be fitted to the connecting board.

Connecting board

The connecting board contains all paths between the bus board and the inputs and recording outputs. Also fitted to this board are the preset potentiometers (except for those for MM). Figure 6 shows the "circuit" of the connecting board: it consists of a number of tracks and a few preset potentiometers. Of course, these preset potentiometers can be replaced by wire links or a potential divider consisting of two resistors. The advantage is a reduction in noise.

The printed circuit board in figure 7 consists of two parts: the actual connecting board and a board to which the sockets are fitted. It must be separated into these two parts, and the 16 sockets and 8 preset potentiometers must then be installed. Once the phono sockets have been fitted to the socket board, the solder lugs can be connected to the corresponding terminals on the board with short lengths of wire. The preset potentiometers must be of the vertical type. Once the completed board has been installed in a housing, they must be accessible from above or below to allow adjustments to be made. When purchasing them, therefore, one should ensure that the preset potentiometers can be adjusted from both sides. Incidentally, they should be positioned in such a way that the signal level increases when the wiper is rotated anti-clockwise, viewed from above. The terminals of the socket board and of the actual connecting board are connected according to the proper designations, using short lengths of wire.

There is not much that can be tested here; a visual inspection should be sufficient. Finally, the finished construction can be put to one side and we can turn our attention to the headphone amplifier, described elsewhere in this issue.

Next month:

- **bus board**
- **front panel**
- **line amplifier**
- **signal indicator**

Recently, the growth in the number of video hobbyists has kept pace with that of computer 'freaks'. For this reason, we would like to devote more articles to the field of video in future. The colour modulator presented here will also be of interest to computer fans; it is driven from the RGB output of a personal computer, thus enabling the domestic TV set to reproduce the pictures and 'home-composed' audio.

VAM - video/audio modulator

colour pictures and sound from your personal computer

First of all, let us answer the question: What is a video modulator? This could be described as a kind of miniature TV transmitter which processes a video signal in such a way that it is suitable for application to the aerial input of a conventional TV set. It is an essential element in a TV games computer, for example, or a test pattern generator. It is also required by a Videotext decoder or TV terminal for a personal computer. Several video modulators have already been published in Elektor. However, the last design dates back to the October 1978 issue and is not suitable for colour applications. Moreover, it cannot be used for audio and the sound must be applied to a separate amplifier. This means that the sound section of the TV set remains silent, which is a pity. It is not an elegant solution from the technical point of view.

These various factors prompted the design of a new circuit which is suitable for modulating both video *and* sound. The circuit is of such universal design that it can be used for a wide number of applications.

Design

The intention is for the user of the VAM to be able to convert the RGB signal generated by this hobby computer, test pattern generator or other source into a video signal of his choice. This was a basic requirement of the VAM in the development stage. The circuit was to be equipped with digital R(ed), G(reen), B(lue) inputs, a separate audio input, and a video output. After some reflection, the 'Teletext Decoder published in the November 1981 issue was

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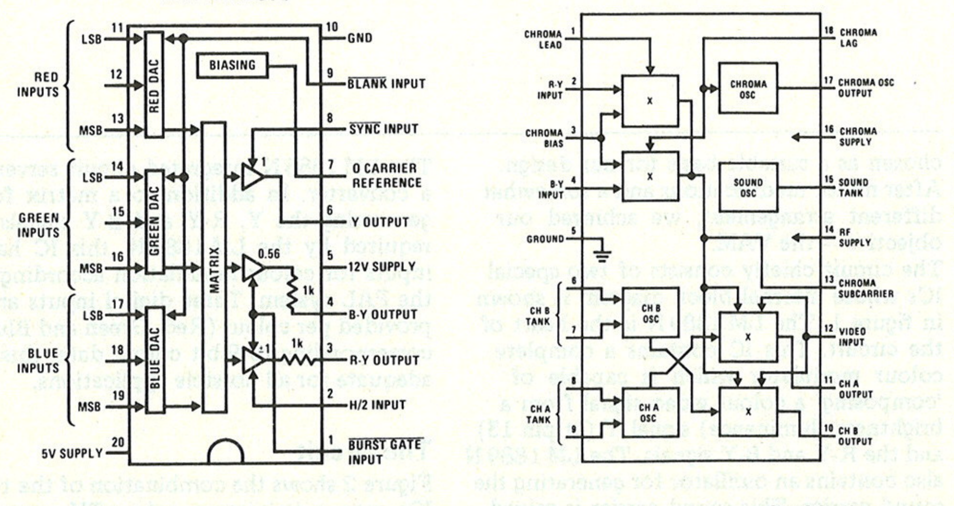

Figure 1. The two most important components for the VAM miniature colour TV transmitter: LM 1886 N (video matrix and D/A converter) and LM 1889 N (video modulator).

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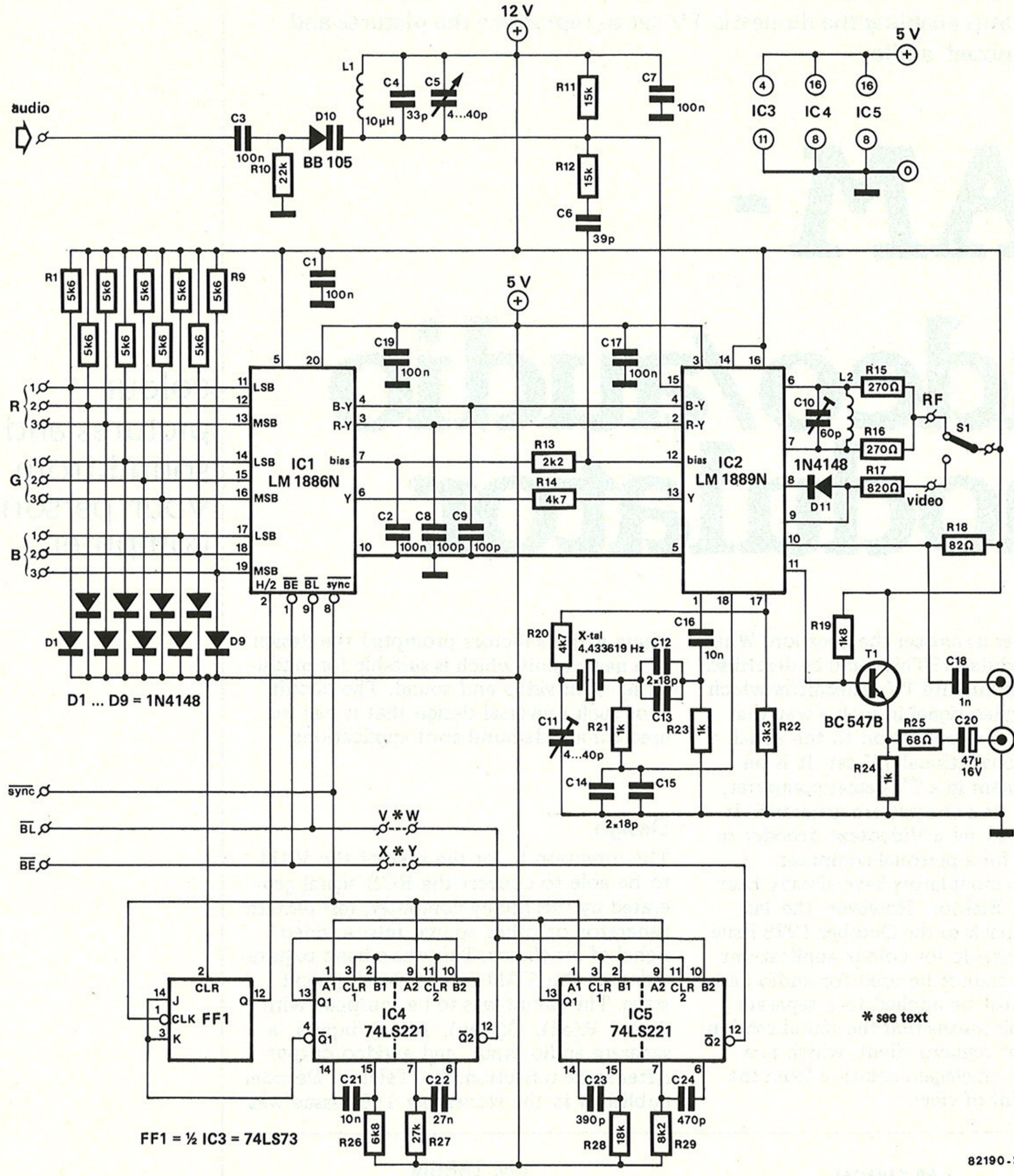

Figure 2. Circuit of the VAM – video/audio modulator. RGB and audio signals in, VHF or video signal out.

chosen as a suitable basis for our design. After minor modifications and a somewhat different arrangement, we achieved our objective – the VAM.

The circuit chiefly consists of two special ICs whose internal block diagram is shown in figure 1. The LM 1889 N is the heart of the circuit. This IC contains a complete colour modulator which is capable of 'composing' a colour video signal from a brightness (luminance) signal Y (at pin 13) and the R-Y and B-Y signals. The LM 1889 N also contains an oscillator for generating the sound carrier. This sound carrier is mixed with the video signal via pin 12.

The LM 1886 N integrated circuit serves as a converter. In addition to a matrix for generating the Y, R-Y and B-Y signals required by the LM 1889 N, this IC has inputs for colour modulation according to the PAL system. Three digital inputs are provided per colour (Red, Green and Blue), corresponding to 9-bit colour data; this is adequate for all possible applications.

The circuit

Figure 2 shows the combination of the two ICs into a 'miniature colour-TV power encoder'.

The different inputs can be seen on the left of the figure. The most important ones are the 9 RGB inputs, sync input and audio input. The VHF and video outputs are on the right of the figure. They can be optionally selected by means of S1. The LM 1886 N and LM 1889 N are designated here as IC1 and IC2 respectively and interconnected via lines B-Y, R-Y, bias and Y. ICs 3, 4 and 5 are needed to able to obtain the burst-anable ($\overline{\text{burst}}$) and H/2 (for the PAL switch) signals required for generating a PAL video signal. Additionally, a blanking pulse (BL) is generated with these ICs; this suppresses the picture information during vertical synchronisation.

However, the pulse is only required when no external BL signal is available. We shall examine this in more detail later.

The audio modulator in the upper part of figure 2 is a simple circuit. A resonant circuit (L1, C4, C5) at the intercarrier frequency (6 MHz) is frequency modulated by means of varicap diode D10. The audio signal serves as modulation signal. Since the circuit mentioned is a part of the oscillator contained in IC2, the sound is also modulated in this way. Input sensitivity of the audio modulator is approximately 1 V_{rms}.

We shall now consider the signals in more detail.

RGB

Three inputs are provided for each of the red, green and blue signals. Eight levels can therefore be realised per colour, resulting in a total of $2^9 = 512$ different colour shades. The coding for the most common colours is listed in table 1.

For simple applications the three R, G and B inputs can be interconnected, so that only one input is available per colour. *One* pull-up resistor (R1, R4, R7) and *one* limiting diode (D1, D4, D7) is utilised per group of three in this case. The selection is thus restricted to six colours plus black and white. This may not appear to be much, but it is satisfactory in most cases, e.g. for microcomputers with digital RGB outputs.

Such microcomputers often supply an NTSC colour signal which is of little use in the UK and continental Europe. However, the VAM can be directly utilised as an 'adapter' between these computers and the aerial or video input of a PAL colour television set. In these cases problems are sometimes encountered with the vertical synchronisation (60 Hz for NTSC). In general, however, the TV set can easily be readjusted.

One more comment: if the RGB inputs are driven by TTL, the pull-up resistors and limiting diodes can be omitted.

$\overline{\text{Sync}}$

The sync signal must be applied to the circuit without fail. For this reason it is also provided by every video signal source. Pulses (logic zero) which can be directly used as a $\overline{\text{sync}}$ signal are those with a width of about 4 μs and a repetition frequency of 15625 Hz (64 μs). Additionally, the pulse train must contain an interval of approximately 500 μs (7.5 x 64 μs, to be precise) every 20 ms for purposes of vertical synchronisation. During the interval, the synchronisation signals deliver a substitute signal which is inverted with respect to the original $\overline{\text{sync}}$ signal and which has twice the frequency. This doubled frequency is used in the VAM to suppress the burst pulse. We shall examine the $\overline{\text{BE}}$ (burst enable) signal later. Incidentally, a combined (horizontal plus vertical) $\overline{\text{sync}}$ signal is not always available. In this case the horizontal ($\overline{\text{HS}}$) and vertical ($\overline{\text{VS}}$) components must be combined into a $\overline{\text{sync}}$ signal. Figure 3 shows a simple circuit: an AND gate (3a) or two tri-state buffers (3b) form the desired $\overline{\text{sync}}$ signal from the $\overline{\text{HS}}$ and $\overline{\text{VS}}$.

$\overline{\text{BL}}$ = blanking

The $\overline{\text{BL}}$ signal is not absolutely necessary. Its purpose is to suppress the input signals at the RGB inputs. In most cases this suppression already takes place in the computer or test pattern generator, thus making an external blanking signal superfluous. If necessary, the VAM can provide an external although 'primitive' rasterblanking signal. This will be discussed in the description of the $\overline{\text{BE}}$ signal.

When applying a $\overline{\text{BL}}$ signal, care should be taken to ensure that it is active during the logic zero periods.

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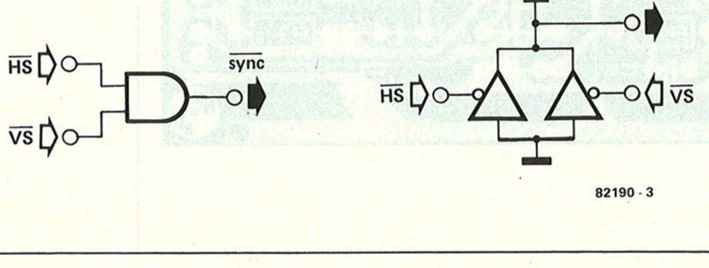

Figure 3. If only a horizontal and a vertical sync signal are available, the two can be combined in this way.

$\overline{BE}$ = burst enable

The sync signal is immediately followed by a short pulse (approximately 9 periods), to synchronise the TV set with the colour demodulator. The task of the $\overline{BE}$ signal is to establish the instant at which this pulse is emitted. To prevent the TV set from 'flipping out' during the raster-sync (vertical-sync) pulses, the $\overline{BE}$ signal is suppressed during this period.

On the one hand, the PAL flip-flop IC3 is prevented from reacting to the double sync-frequency by means of IC4 ($\overline{Q}1$ – see figure 2); FF1 continues to follow the same rate. On the other hand, a blanking signal of approximately 600 μs in duration is generated as soon as IC4 signals this double frequency (when a new sync pulse appears within 40 μs). This signal can serve for raster blanking via wire link V-W, instead of an external $\overline{BL}$ signal. However, this blanking signal is mainly required to suppress the $\overline{BE}$ pulse.

Here are two more points. Firstly, it should be noted that when the VAM is used as a monochrome modulator the oscillator connected to pins 1, 17 and 18 of IC2 becomes superfluous. In this case the $\overline{BE}$ signal is not required either, because it is normally employed to modulate the phase of this oscillator together with the RGB signals (converted to R-Y and B-Y). The second

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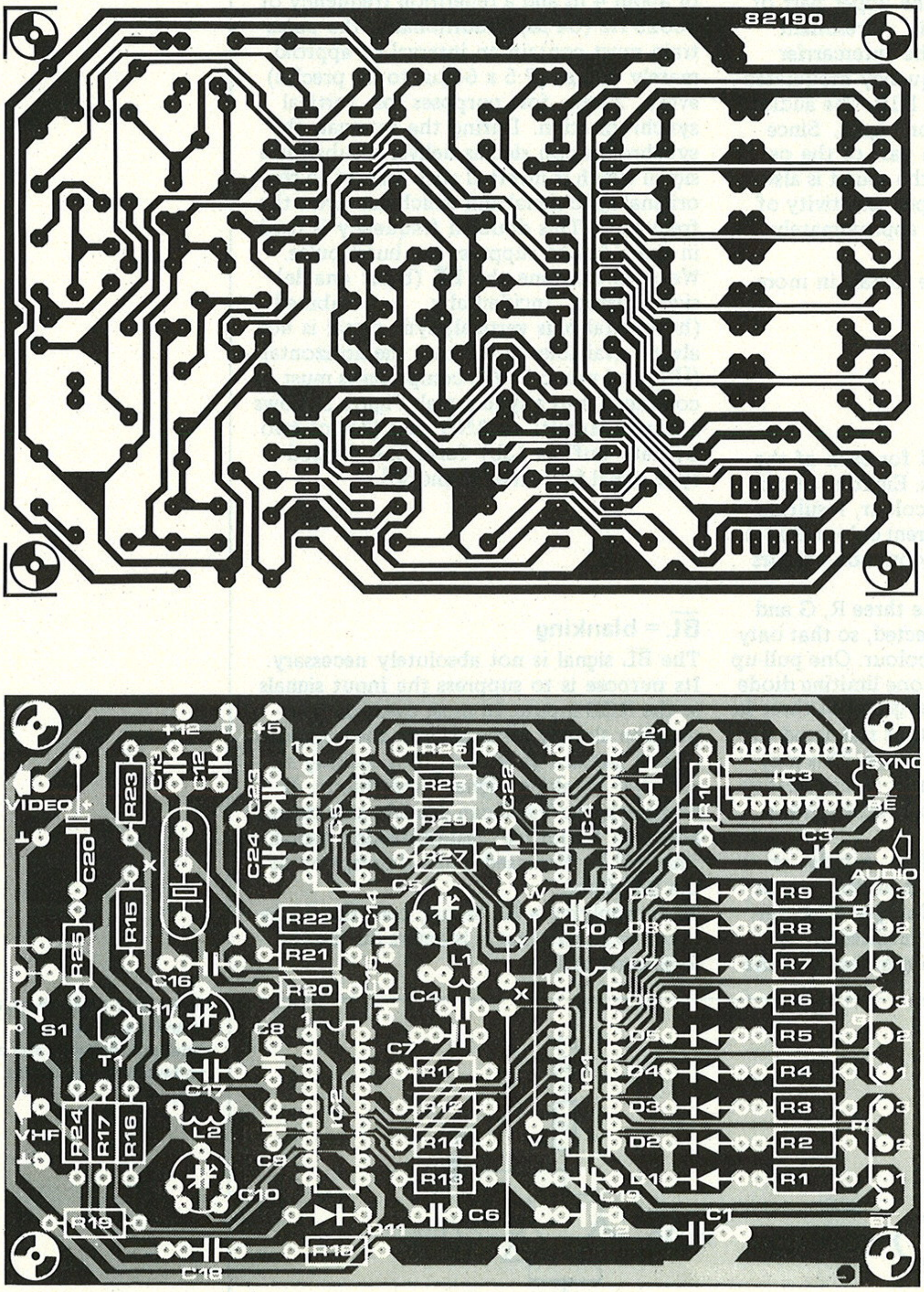


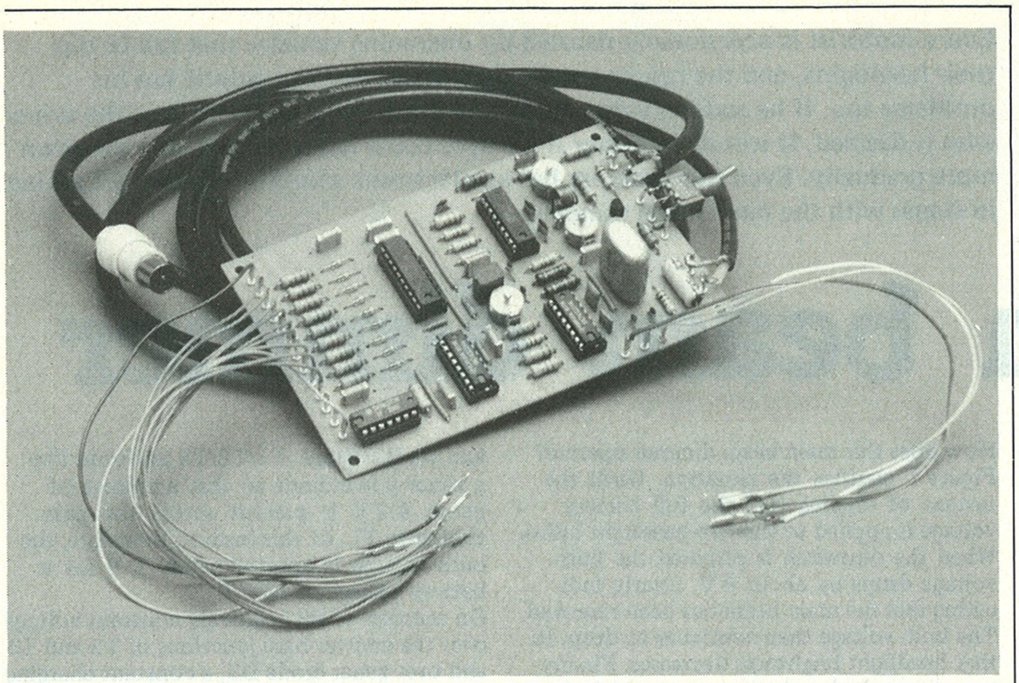
Parts list

Resistors:
R1 . . . R9 = 5k6
R10 = 22 k
R11,R12 = 15 k
R13 = 2k2
R14,R20 = 4k7
R15,R16 = 270 Ω
R17 = 820 Ω
R18 = 82 Ω
R19 = 1k8
R21,R23,R24 = 1 k
R22 = 3k3
R25 = 68 Ω
R26 = 6k8
R27 = 27 k
R28 = 18 k
R29 = 8k2

Capacitors:
C1 . . . C3,C7,C17,C19 = 100 n
C4 = 33 p
C5,C11 = 4 . . . 40 p trimmer
C6 = 39 p
C8,C9 = 100 p
C10 = 10 . . . 60 p trimmer
C12 . . . C15 = 18 p
C16,C21 = 10 n
C18 = 1 n
C20 = 47 μ/16 V
C22 = 27 n
C23 = 390 p
C24 = 470 p

Semiconductors:
D1 . . . D9,D11 = 1N4148
D10 = BB 105 (varicap-diode)
T1 = BC 547B
IC1 = LM 1886 N (National Semiconductor)
IC2 = LM 1889 N (National Semiconductor)
IC3 = 74LS73
IC4,IC5 = 74LS221

Miscellaneous:
L1 = 10 μH
L2 = 6 turns enamelled copper (0.8 mm φ) on 6 mm former
S1 = changeover switch
Xtal = 4,433619 MHz crystal



This compact unit converts digital colour and tone signals into a clean 'composite video' signal. If desired, a UFH modulator can be added, so that the signal can be applied to an aerial input.

point, which may seem obvious, is that the $\overline{BE}$ signal can also be applied externally. In this case, X-Y remains open circuit.

Practice

Construction of the VAM should present no problems using the printed circuit board shown in figure 4. All inputs are arranged at one edge of the p.c.b. Located at the other edge are the VHF and video outputs and the terminals for switch S1, which is used to select one of the two outputs. The supply voltage terminals are at one of the longer edges of the p.c.b..

Two different supply voltages are required: +12 V and +5 V. The 12 V rail must be capable of supplying approximately 60 mA and the 5 V rail approximately 10 mA. Since no other special demands are made on the power supply for the VAM, it is possible to use the teletext power supply from the February 1982 issue, for example.

When fitting the components to the p.c.b. it should be noted that a total of six wire links must be installed. Two of these wire links are alternatives: if an external $\overline{BL}$ signal is applied, wire link V-W is omitted. If an external $\overline{BE}$ signal is applied, link X-Y is omitted.

Alignment

Alignment is fairly simple. It is merely necessary to adjust three trimmer capacitors: C5, C10 and C11. The oscillator circuit of the audio modulator is tuned to precisely 6 MHz by means of C5. This is easier than one might think. In practice the trimmer is set to minimum audible noise and maximum level.

C11 is used for fine adjustment of the colour carrier frequency. The range of adjustment is relativily narrow, because this is a crystal-controlled frequency. The colour TV set will display a good picture within a particular capacitance range of C11. The trimmer should therefore be set to the midpoint of this range.

		INPUT CODE		
		RED	GREEN	BLUE
	Colour	M L	M L	M L
	Black	0 0 0	0 0 0	0 0 0
	Dark Grey	0 1 0	0 1 0	0 1 0
	Light Grey	1 0 1	1 0 1	1 0 1
	White	1 1 1	1 1 1	1 1 1
Primary	Red	1 1 1	0 0 0	0 0 0
	Green	0 0 0	1 1 1	0 0 0
	Blue	0 0 0	0 0 0	1 1 1
Complementary	Cyan	0 0 0	1 1 1	1 1 1
	Magenta	1 1 1	0 0 0	1 1 1
	Yellow	1 1 1	1 1 1	0 0 0
	Brown	0 1 1	0 1 1	0 0 0
	Orange	1 1 1	1 0 0	0 0 0
	Flesh tone	1 1 1	1 1 0	1 0 1
	Pink	1 1 1	1 1 0	1 1 0
	Sky Blue	1 0 1	1 0 1	1 1 1

Table 1. Coding for the most common colours.

Last but not least, C10. The main purpose of this trimmer is to allow adjustment of the VHF output frequency. If switch S1 is set to the 'RF' position, the output signal can be tuned to VHF channels 2, 3 and 4. Fine adjustment can be made using the appropriate potentiometer in the TV set. Readers fortunate enough to have a TV set with a video input should connect it to the corresponding output of the VAM. Picture quality will probably be somewhat better.

It is also possible to obtain video via a channel in the UHF band. This necessitates a modulator, however, to which the video signal of the VAM is then applied. A suitable modulator, for example, is the VHF/UHF modulator described in the October 1978 issue. ◄

Every motorist is occasionally dazzled by oncoming vehicles that fail to dip their headlights, and the results can be dangerous. But the culprit has his problems too. If he suddenly dips his headlights he will see as little as the driver who is dazzled. It would be better if his eyes could adjust to the new situation more gradually. Even this problem has an electronic solution: dimming/dipping in stages with the main beam dimmer.

main beam dimmer

headlight dimmer/dipper

How does this main beam dimmer operate? Figure 1 clarifies the situation. Until the instant of dipping (t_0) the full battery voltage is applied to the two headlight bulbs. When the dipswitch is actuated the bulb voltage drops by about 4 V, clearly indicating that the main beam has been removed. The bulb voltage then continues to drop, so that headlight brightness decreases. Finally, t_{max} is reached – the instant at which the main beam is fully switched off – and only the dipped headlights are active.

Circuit

Fortunately, the apparently complicated response illustrated in figure 1 can be duplicated with fairly simple electronics. Figure 2 shows the circuit of the main beam dimmer. This dimmer/dipper can be compared to a power supply with series-pass stabilisation. However, the 'regulation' between t_0 and t_{max} takes place considerably more slowly.

At time t_0, the relay contact for the main beam is opened. At this instant, capacitor C1 is discharged. Thus the voltage across it is approximately 0 V. A low current flows via the emitter-base diodes of T2 and T3, and via D3. Stage T1/T2/T3 performs like a zener powerdiode so that a voltage of about 4.2 V is present across the pass transistor T1. At this instant, therefore, the bulb voltage is approximately 9 V (at a battery voltage of 13.2 V).

On account of the relatively constant voltage over the emitter-base junctions of T2 and T3 and over zener diode D3, a constant charging current for electrolytic capacitor C1 now flows via P1. With P1 set to its midpoint the current is approximately 190 μA. The voltage over C1 rises at a rate of 4 V/s. Once it reaches 7.5 V (voltage over the emitter-base junction of T4 and over zener diode D4), T4 conducts and capacitor C1 charges very rapidly up to the maximum voltage. The pass transistor then turns off completely so that the current for the main beam bulbs ceases to flow. A minimum voltage rise, i.e. a 'dimming time', of 2 V/s can be adjusted with P1.

Diodes D1 and D2 ensure that capacitors C1 and C2 can discharge immediately after the headlight flasher is actuated or the main beam is switched on, thus making the circuit operational again.

An important point to note is that on some

Figure 1. The response of the main beam dimmer is that of dimming/dipping in stages. Time $t_0 \ldots t_{max}$ can be varied.
At t_0, the dip switch is operated. The dipped headlights come on immediately, at full brightness, and the main beam is dimmed quite noticeably. Then the main beam is dimmed down further, during a set period, after which it is cut off entirely.

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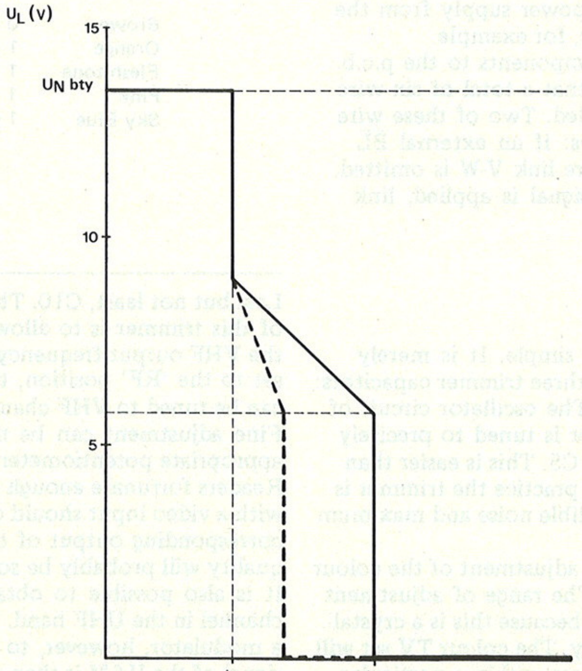

cars the ignition lock is also the main switch, as shown in figure 2. When the ignition is switched off there is no voltage at point A. If the engine is started, then of course the effect shown in figure 1 is encountered. But we just have to live with this situation! The current flowing at this instant could result in a much more unpleasant effect. In laboratory trials the 2N3055 survived all attempts to destroy it. However, those readers with any doubts should substitute a 2N3771 or 2N3772 for the 2N3055.

Construction and installation

Construction is made simple by the printed circuit board of figure 3. Transistor T1 is fitted to the p.c.b. together with the finger-type heatsink. Use serrated washers between the nuts and the copper surface to ensure good electrical contact.
The two leads are made from vehicle-type wiring and appropriate lugs or spade terminals are fitted to their ends. The other two ends are soldered directly to the p.c.b.. Grommets are fitted to the through-holes for the two leads and it may be necessary to seal them. The assembly is then installed in a case (whether waterproof or not will depend on the mounting location) and fitted at a suitable point – preferably near the fusebox.
The relay contact for the main beam must now be located and the two leads A and B connected according to figure 2 (do not reverse them!). The main beam dimmer can be disabled with switch S1.
All that remains is a functional check. The unit should operate in accordance with figure 1. A functional check using the headlight flasher should also be made. ◀

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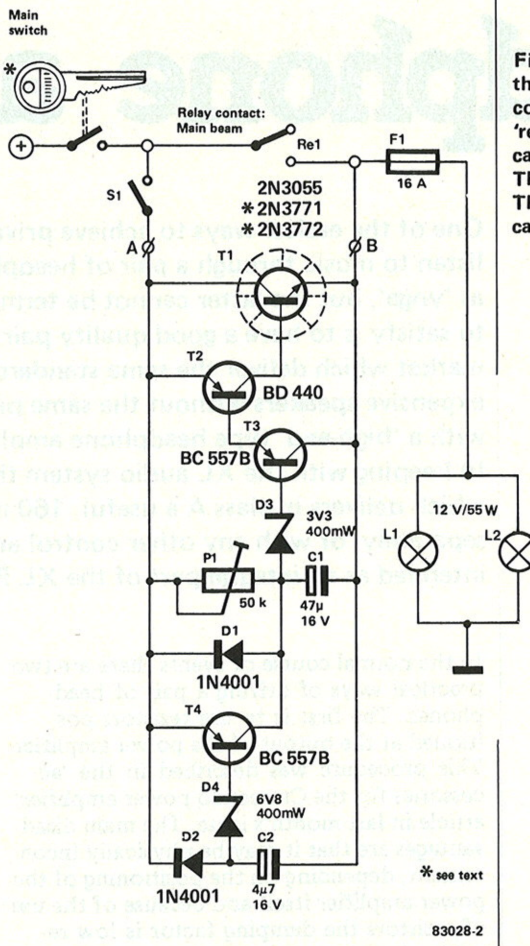

Figure 2. The circuit for this complicated response consists of a series-pass 'regulator' (T1) and two capacitor charging circuits. The result? See figure 1. The main beam dimmer can be disabled with S1.

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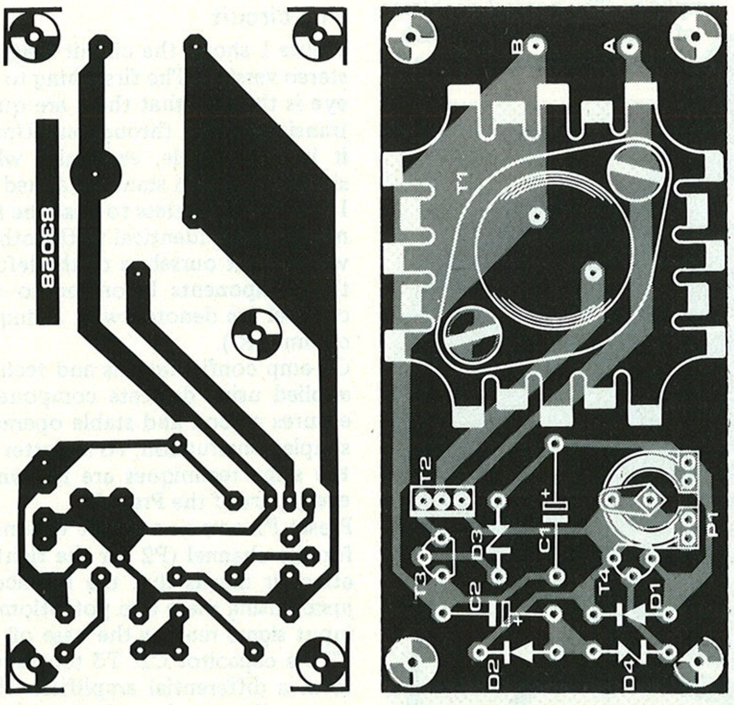

Figure 3. Track pattern and component layout of the printed circuit board for the main beam dimmer. T1 is fitted with a finger-type heatsink.

Parts list

Resistor:
P1 = 50 k preset

Capacitors:
C1 = 47 µ/16 V
C2 = 4µ7/16 V

Semiconductors:
D1,D2 = 1N4001
D3 = zener diode 3V3/0.4 W
D4 = zener diode 6V8/0.4 W
T1 = 2N3055
T2 = BD 440
T3,T4 = BC 557B

Miscellaneous:
Finger-type heatsink for T1 45 mm x 45 mm x 25 mm (e.g. FK 201)

Prelude: class A headphone amplifier

One of the easiest ways to achieve privacy from everyone around you is to listen to music through a pair of headphones. There are cheaper methods such as 'yoga', but the latter cannot be termed as easy. Obviously the first criterion to satisfy is to have a good quality pair of headphones. There are many on the market which deliver the same standard of reproduction as the top quality expensive speakers without the same price label. Even so, unless they are used with a 'high-end' type headphone amplifier the whole exercise would be futile. In keeping with the XL audio system this article introduces such an amplifier, which delivers in class A a useful 160 mW per channel into 8 Ω. It can be used separately, or with any other control amplifier even though it was originally intended as an integral part of the XL Prelude.

mini-power amplifier for private listening

In the normal course of events there are two practical ways of driving a pair of headphones. The first is to use resistors positioned at the output of the power amplifier. This procedure was described in the 'accessories for the Crescendo power amplifier' article in last month's issue. The main disadvantages are that it may be physically inconvenient, depending on the positioning of the power amplifier itself and because of the use of resistors the damping factor is low resulting in poor bass response.

The second is to construct a totally separate amplifier. This is by far the best solution and because only a small output power is required, excellent quality can be achieved with a class A type amplifier. The normal problems of heat dissipation (as with large class A amplifiers) are not encountered, simply because of the low output power. Apart from the overall quality of the resulting reproduction a class A type has the unrivaled advantage of not having any crossover distortion what so ever!

The headphone amplifier introduced here was originally designed for the 'Prelude' pre-amplifier, so the printed circuit board is fully compatible with the rest of the 'Prelude' and XL system. However as it is self contained it can be used independently, only needing a separate power supply (± 15 V/250 mA), or with any other control amplifier.

The circuit

Figure 1 shows the circuit diagram of the stereo version. The first thing to strike the eye is the fact that there are quite a few transistors used throughout. Unfortunately it is unavoidable, especially when considering the high standard aimed at.

It is rather pointless to describe both channels as one is identical to the other, so, we will restrict ourselves to the left side. All the components belonging to the right channel are denoted with a single inverted comma (R').

Op-amp configurations and techniques are applied using descrete components. This ensures a good and stable operation, with simple construction. As a matter of interest the same techniques are implemented in every part of the Prelude.

Preset P1 acts as a preset volume control for the channel (P2 for the right one). In effect it means that the balance is adjusted using these two potentiometers. The input signal reaches the base of transistor T3 via capacitor C1. T3 together with T4 form a differential amplifier. The direct current flowing through this stage is supplied by a current source constructed around T5.

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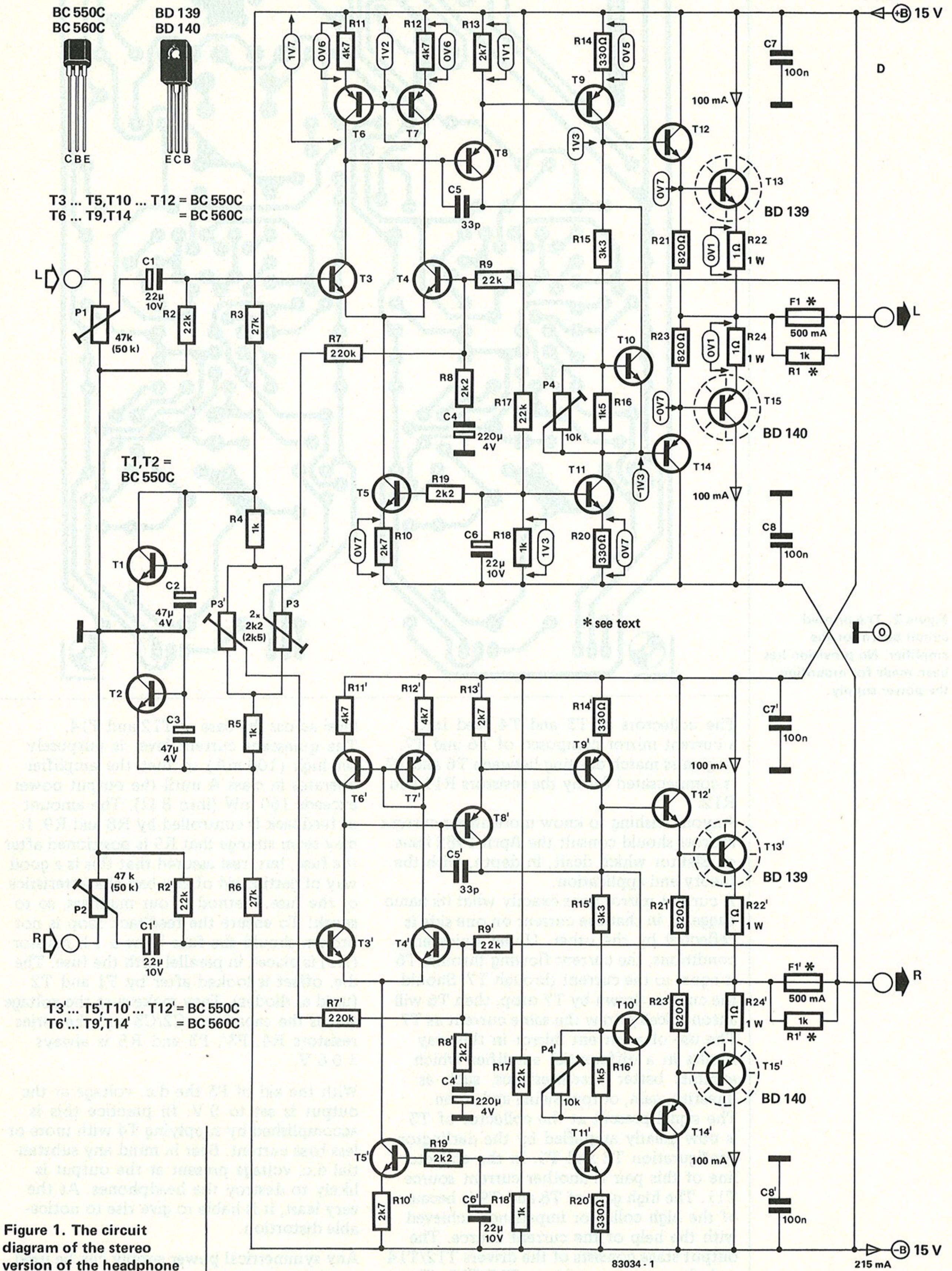

Figure 1. The circuit diagram of the stereo version of the headphone amplifier. The important aspect is the fact that it uses two class A output stages.

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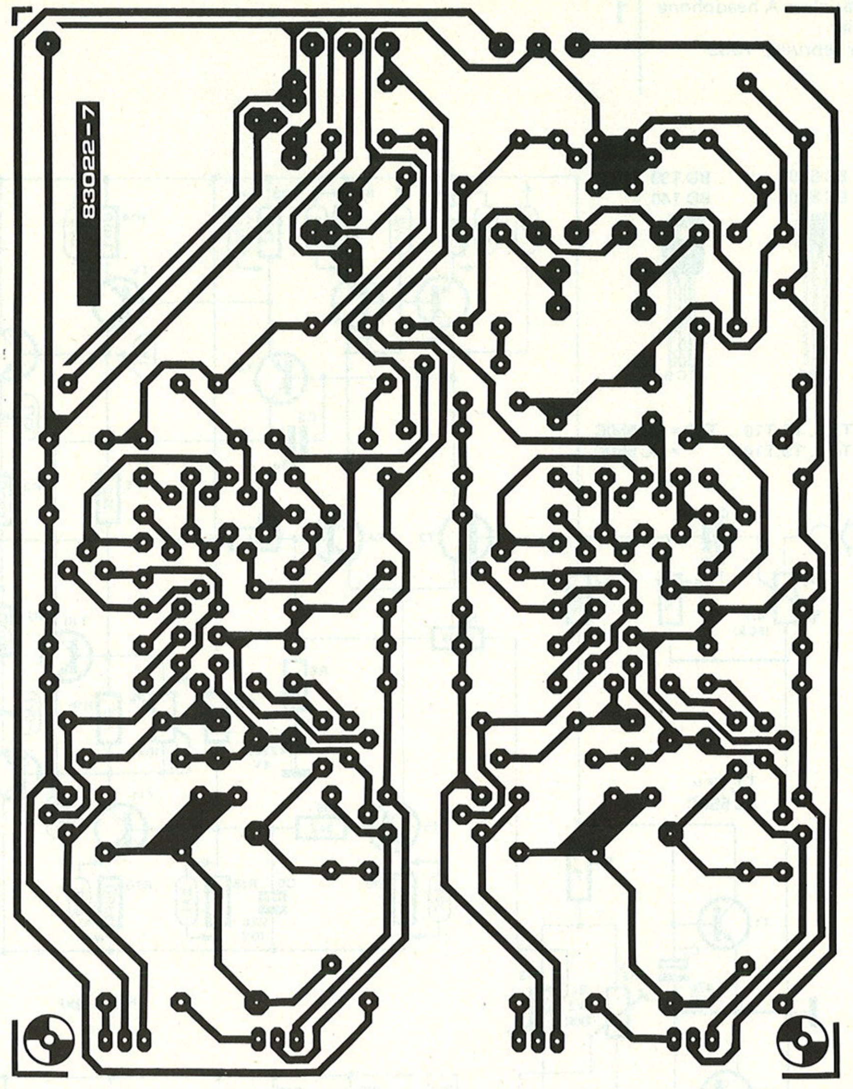


Figure 2. The printed circuit board for the amplifier. No provision has been made for mounting the power supply.

The collectors of T3 and T4 feed into a current mirror composed of T6 and T7. Any miss-match existing between T6 and T7 is compensated for by the resistors R11 and R12.

Anyone wishing to know more about current mirrors should consult the April 1982 issue of Elektor which dealt, in depth, with the theory and application.

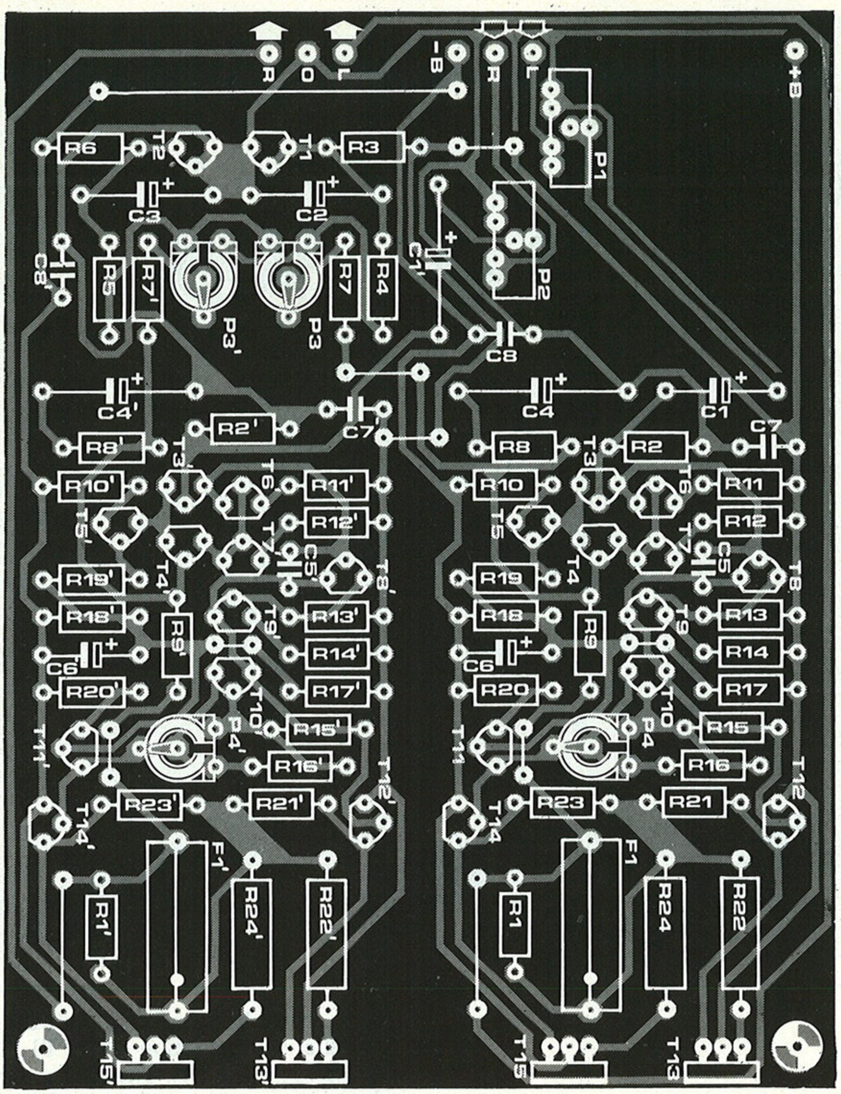
A current mirror does exactly what its name suggests, in that the current on one side is reflected by the other. Under quiescent conditions, the current flowing through T6 is equal to the current through T7. Should the current drawn by T7 drop, then T6 will automatically draw the same current as T7. The use of a current mirror in this way results in a differential amplifier which exhibits better characteristics, such as: linearity, gain, output swing and so on.

The signal present at the collector of T3 is now greatly amplified by the darlington configuration T8 and T9. In the collector line of this pair is another current source T11. The high gain of T8 and T9 is because of the high collector impedance achieved with the help of the current source. The output stage consists of the drivers T12/T14 and the power transistors T13/T15. The quiescent current is determined by T10. Basically P4 sets the collector/emitter voltage of T10 which in turn determines the voltage level across the base of T12 and T14.

The quiescent current level is purposely set high (100 mA) so that the amplifier operates in class A until the output power exceeds 160 mW (into 8 Ω). The amount of feedback is controlled by R8 and R9. It may seem strange that R9 is positioned after the fuse, but, rest assured that this is a good way of getting rid of any bad characteristics of the fuse. Method in our madness, so to speak! To ensure the feedback loop is not broken should the fuse blow a 1 k resistor (R1) is placed in parallel with the fuse. The d.c. offset is looked after by T1 and T2 (used as diodes). They make sure the voltage across the capacitors C2/C3 and the series resistors R4, P3', P3 and R5 is always ± 0.6 V.

With the aid of P3 the d.c. voltage at the output is set to 0 V. In practice this is accomplished by supplying T4 with more or less base current. Bear in mind any substantial d.c. voltage present at the output is likely to destroy the headphones. At the very least, it is liable to give rise to noticeable distortion.

Any symmetrical power supply can be used providing it delivers a minimum of 250 mA at ± 15 V. It should be short circuit protected to ensure a maximum current consumption of 1 A. The best solution is to



use one of the modern voltage regulators, which are easily available.

Construction

The printed circuit board is illustrated in figure 2. We strongly suggest the use of top quality components, especially when considering the semiconductors. The better the parts the better the final result. Resistors R1, R1' and fuses F1, F1' are for current level protection (protecting equipment connected to the output). They do not protect the actual amplifier in any way, as the fuses react too slowly. They can be removed if desired and wire links put in their place.
The output transistors T13, T15, T13' and T15' need cooling. Separate heat sinks can be mounted, or one large one for all four. Keep in mind in the latter case each transistor has to be electrically isolated from the others. Obviously the rear of a suitable case can come in handy for this purpose, especially if building the complete Prelude. These constructional aspects have been taken into account for the overall design of the Prelude pre-amplifier.
We must re-emphasise the power supply must be stabilised, short-circuit proof, and current limited to a maximum of 1 A. The Prelude power supply as described in the pre-amplifier article elsewhere in this issue conforms to these parameters. The 7815 or 7915 voltage regulators were found to be ideal when constructing a completely separate supply.

Calibration

Start with the wipers of P3' and P3 in the mid position, and P4', P4 fully to the left (anticlockwise). Now set a multimeter to the 500 mV d.c. range and connect it to the emitters of T13 and T15. Turn P4 clockwise until you have a reading of 200 mV. Give the circuit time to 'settle' as the output transistors take a little time to warm-up, and repeat the procedure until a stable 200 mV reading is achieved. The same procedure is required for the other channel.
The meter should now be set to the lowest possible d.c. voltage range. Connect it to the output, and adjust P3 until the meter registers a 0 V reading. Once again repeat for the other channel.

Points to consider

By now you will have noticed the large number of transistors used especially of the BC550C variety. Taking this into consideration, it must be possible to find matched pairs for T3, T4, T3' and T4', thereby improving the already fine specifications of this amplifier. (In fact, if an ideal match is

Parts list

Resistors:
R1,R1',R4,R5,R18, R18' = 1 k
R2,R2',R9,R9',R17, R17' = 22 k
R3,R6 = 27 k
R7,R7' = 220 k
R8,R8',R19,R19' = 2k2
R10,R10',R13,R13' = 2k7
R11,R11',R12,R12' = 4k7
R14,R14',R20, R20' = 330 Ω
R15,R15' = 3k3
R16,R16' = 1k5
R21,R21',R23, R23' = 820 Ω
R22,R22',R24, R24' = 1 Ω/1 W
P1,P2 = 50 k (47 k) vertical preset
P3,P3' = 2k5 (2k2) preset
P4,P4' = 10 k preset

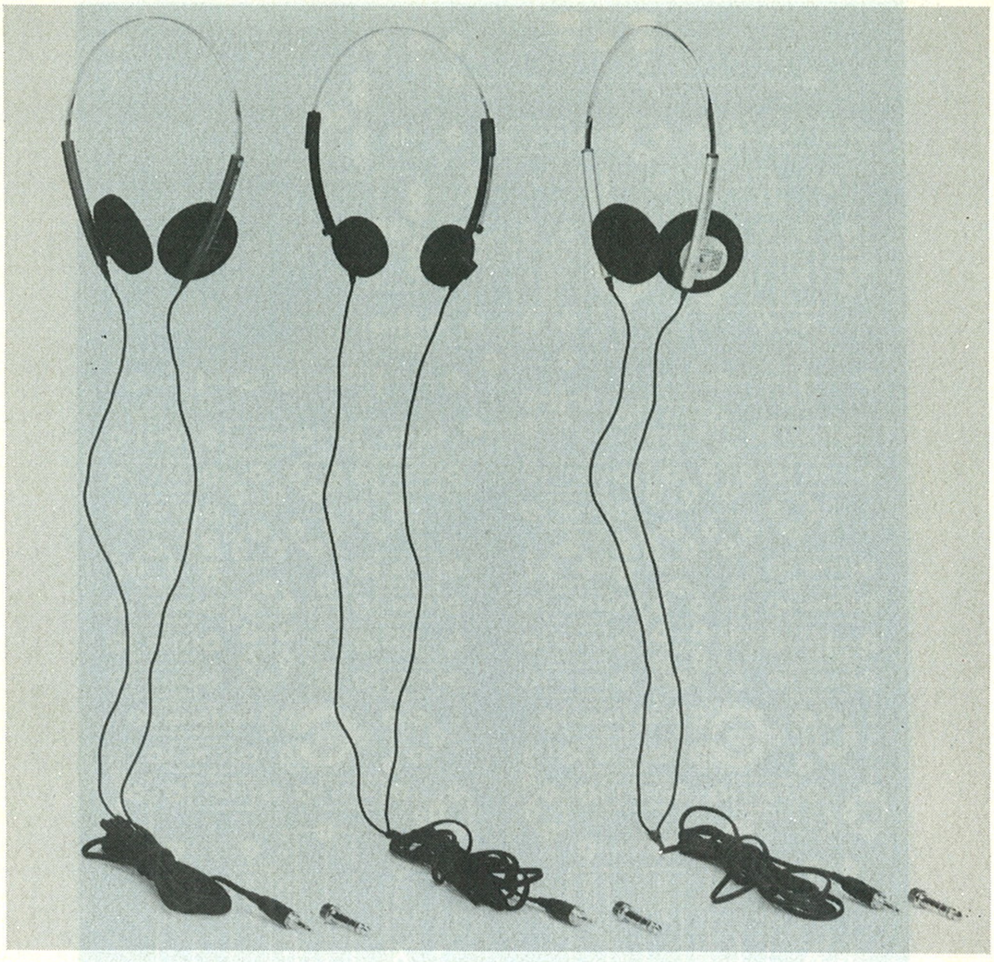
Capacitors:
C1,C1',C6,C6' = 22 µ/10 V
C2,C3 = 47 µ/4 V
C4,V4' = 220 µ/4 V
C5,C5' = 33 p
C7,C7',C8,C8' = 100 n

Semiconductors:
T1 . . . T5,T3',T4',T5', T10,T10',T11,T11',T12, T12' = BC 550C
T6 . . . T9,T6' . . . T9', T14,T14' = BC 560C

Miscellaneous:
F1,F1' = 500 mA, fuses with board mounting holders
Heatsinks for T1 . . . T4

Specifications

Output power in class A:
160 mW into 8 Ω
600 mW into 30 Ω
120 mW into 600 Ω
Harmonic distortion:
0.01% at a nominal
20 . . . 20 000 Hz
Frequency response:
6 Hz . . . 100 kHz ± 0 dB
Signal-to noise ratio:
better than 90 dB
(1 mW into 8 Ω)
Damping factor:
> 80 (20 . . . 20 000 Hz)
into 8 Ω
Input sensitivity:
8 mV for 1 mW into 8 Ω



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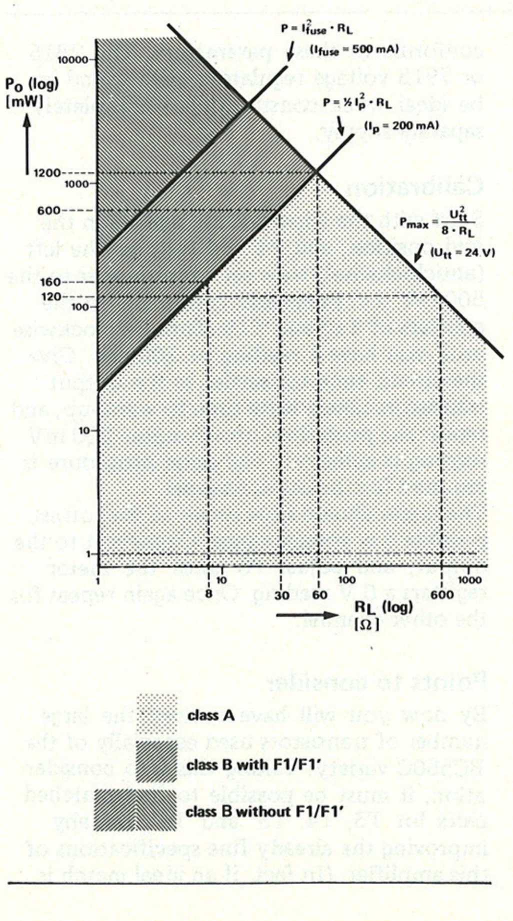


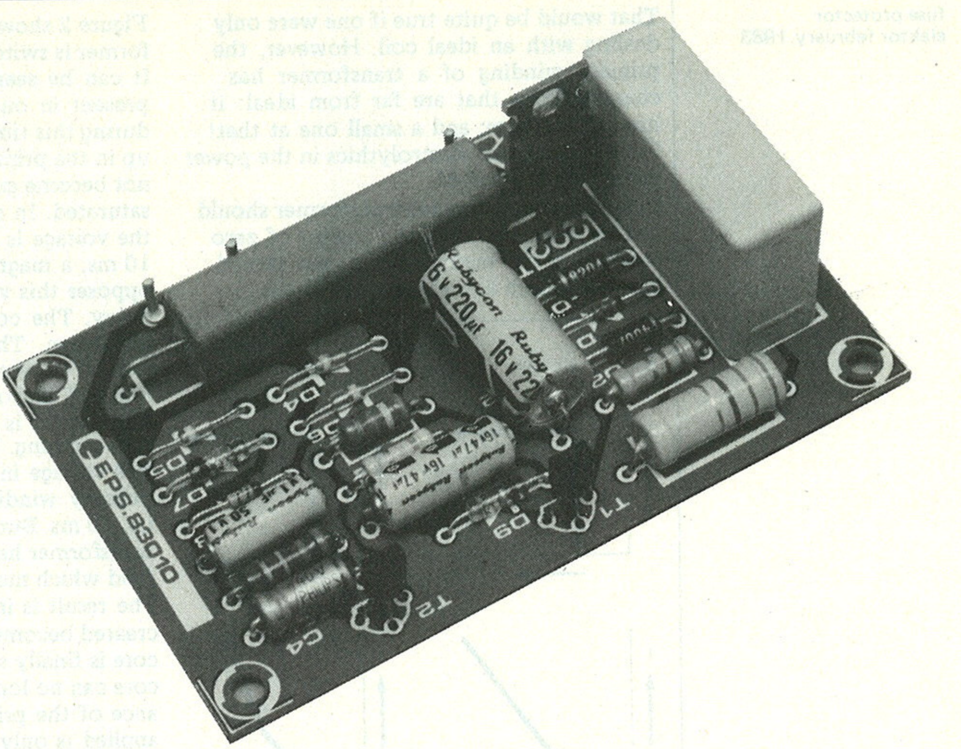
Figure 3. The diagrams show the limits between class A and class B operation, relative to the headphone impedance.

found, it will be possible to omit the complete d.c. compensation stage: T1, T2, C2, C3, R3 . . . R7, R7'!). The easiest method to adopt is to mount transistor sockets for T3 and T4 and just find the right ones by a process of elimination.

At the beginning of the article we mentioned the amplifier operates in class A only until a certain output power level is reached. In practice this point really depends on the impedance of the headphones used. The prototype was tested with quite a few different versions and it was found that nearly any headphone set can be used without exceeding the class A limits.

Figure 3 shows the output power relative to the headphone impedance and further more the limits between class A and B operation. The normal limits are set to 160 mW into 8 Ω and 120 mW into 600 Ω. With a low impedance such as 8 Ω more power is available but obviously only by going into a class B operation. The efficiency of headphone drivers is such (90 to 110 dB for 1 mW input), it is unlikely that you will ever enter the class B range.

However, should you really want it, figure 3 illustrates that even more power is available. If the fuses are replaced by wire links, nearly 10 W can be delivered into 8 Ω! ◾



soft start for high-current equipment

fuse protector

Where circuit breakers are utilised in place of mains fuses, it is quite common for a variety of electrical apparatus, such as amplifiers, halogen movie lights, power saws, etc., to cause the circuit breakers to trip when the apparatus is switched on. Even fuses have been known to blow unexpectedly. The fuse protector is situated electrically between the circuit breaker and the load, acting as an intermediate stage.

H. Dominik

The rating of the new power amplifier is '350 VA max.'.
Thus the maximum power consumption of the amplifier is 350 watts. Since the circuit breaker is rated at 16 A, why does it trip each time the amplifier is switched on?
The paradox seems to contradict Ohm's Law; when connected to the 220 V mains, our amplifier with its 350 watt rating should not draw more than 1.6 A – a tenth of the value required to trip the circuit breaker. Something is wrong: is it our arithmetic, the circuit breaker or the ratings indicated on the amplifier?

Initial current surge

Incandescent bulbs have a so-called cold resistance. This means that the filament material exhibits a positive temperature characteristic. The resistance of a bulb filament at room temperature is only a fraction of that at its operating temperature, about one seventh of the normal resistance. Clearly, it only takes a 500 W lamp to trip the circuit breaker.
The problem is also associated with a particular type of electric motor which is used in domestic apparatus and power tools. This is the series motor, in which the field and armature windings are wired in series. When this motor is switched on (or if it is stalled whilst running) it draws far more current than under normal loading. Adequate self-induction for a sufficiently high impedance is only encountered at sufficient speed. For this reason, circuit breakers will only allow motors rated at less than 1 kVA to be switched on.
The mains transformer in the example of our power amplifier presents something more of a puzzle. Not only does the power formula no longer seem to apply (P/V = I) but the characteristics of a coil and a capacitor appear to have swapped places.

Transformer behaviour

When a mains transformer is switched on, the mains voltage is applied to the primary winding. The latter usually exhibits considerable inductance, and one would think that this would be sufficient to prevent an initial current surge.

That would be quite true if one were only dealing with an ideal coil. However, the primary winding of a transformer has characteristics that are far from ideal: it has an iron core; and a small one at that! Furthermore, the electrolythics in the power supply are discharged.

This means that a mains transformer should not be switched on at the instant of zero crossing of the mains voltage, but should be switched on at a voltage maximum.

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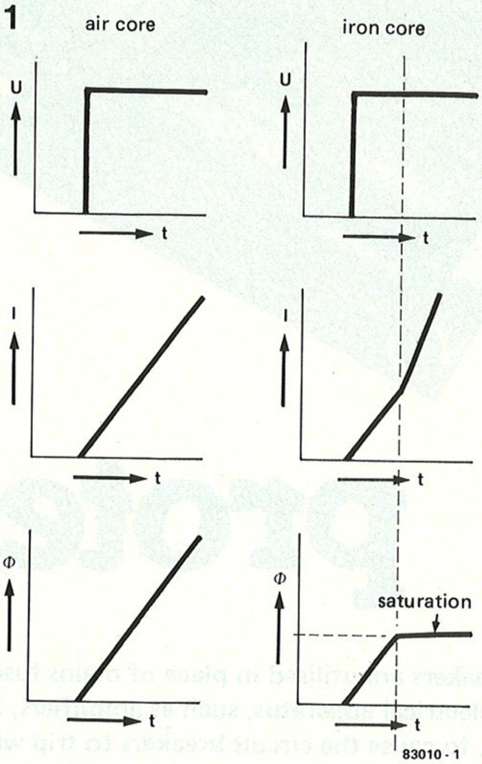

Figure 1. Current and magnetic field when a voltage is applied, showing comparison between air-core coil and coil with iron core. Both coils have the same inductance and the same ohmic resistance. In the case of the coil with an iron core, a steep rise in current is apparent after core saturation.

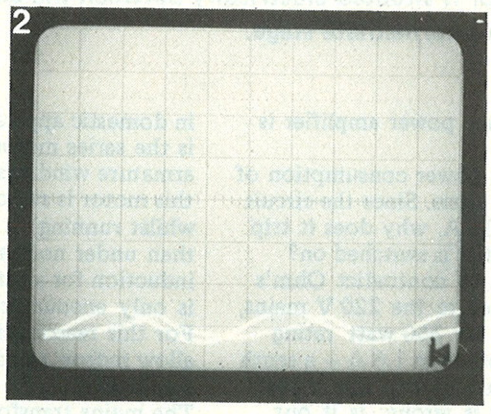

Figure 2. Mains voltage and current of a transformer when switched on at a voltage maximum.

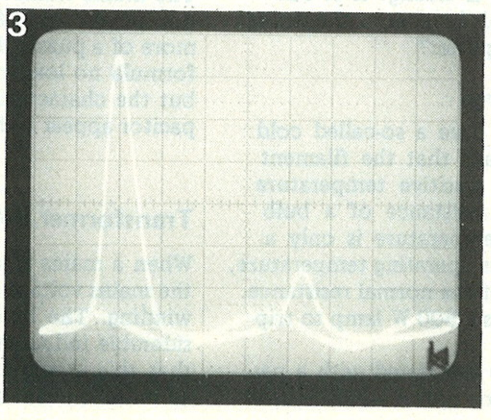

Figure 3. Mains voltage and current of a transformer when switched on at the instant of zero crossing. Once the magnetic field has reached the saturation limit of the core, a current peak is produced.

Figure 2 shows the situation when a transformer is switched on at a voltage maximum. It can be seen that the voltage is only present in one direction for 5 ms. Only during this time can the magnetic field build up in the primary winding; it therefore does not become great enough for the core to be saturated. In subsequent periods in which the voltage is present in one direction for 10 ms, a magnetic field is induced which opposes this voltage and which must first decay. The core therefore cannot reach saturation. The magnetic field and the current lag the voltage nicely by 90°.

Figure 3 illustrates the situation when the transformer is switched on at the instant of zero crossing. In this case a voltage (a positive voltage in figure 3) is present at the primary winding for twice the duration, i.e. 10 ms. But when it is switched on, the transformer has not yet built up a magnetic field which must first decay.

The result is inevitable: the magnetic field created becomes even greater, until the iron core is finally saturated. Since the saturated core can no longer contribute to the inductance of the primary winding, the voltage applied is only opposed by the impedance consisting of the ohmic resistance of the winding and its inductance as a air coil. Since this impedance is very low compared to that with the unsaturated iron core, the result is the current peak shown in figure 3. This current peak can reach values of more than 10-times the value of the normal peak current.

Let us return to our claim that the core of a mains transformer is too small. Of course, this statement only applies to the instant of switching on. If each transformer were dimensioned to prevent initial current surges , the core would have to be more than 50% bigger. The transformer would then be correspondingly heavier and more expensive; this would not be in anyone's interest.

At any rate, one thing is sure: the initial current surge does not harm the transformer. The ideal methods of overcoming these problems are; for the lamps to be switched on at the zero crossing point of the mains supply, transformers at the maximum voltage point, and for motors to be manually rotated before switching on.

With the 'fuse protector' circuit an electronic solution is found. The circuit conducts the mains to the load via a series resistor. The series resistor limits any initial current surges to values that are harmless to the circuit breaker and the circuit.

After the first two seconds, lamps have warmed up sufficiently, motors have developed enough speed and transformers have developed an adequate 'opposing magnetic field' so that the circuit breaker is unaffected when the full mains voltage is applied.

The circuit

As already mentioned, the circuit is connected between the mains and the load. It draws its current via capacitor C3 and limiting resistor R4. The continuous current flowing is 22.5 mA. However, the load is almost

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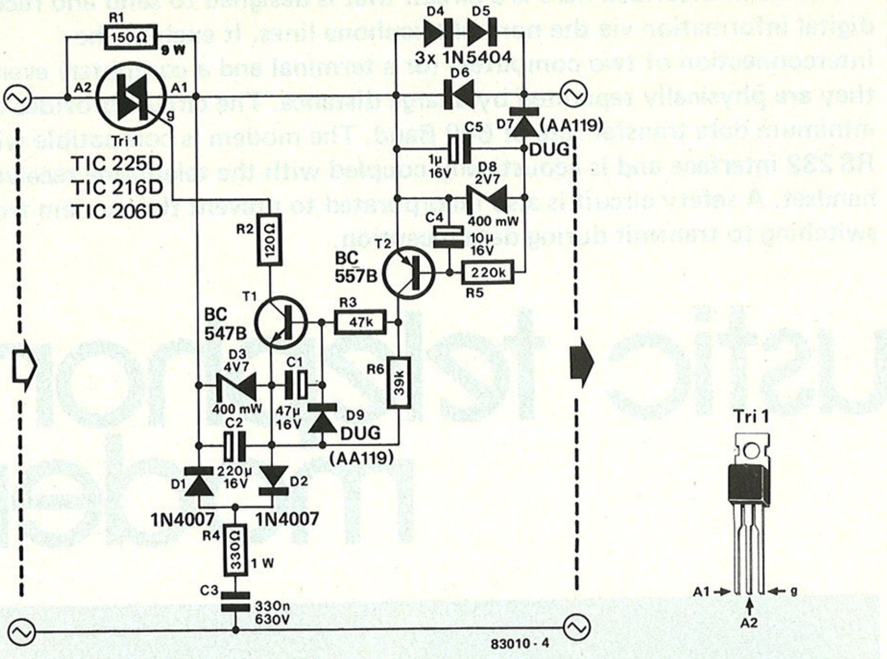

Figure 4. The complete circuit diagram of the Fuse Protector.

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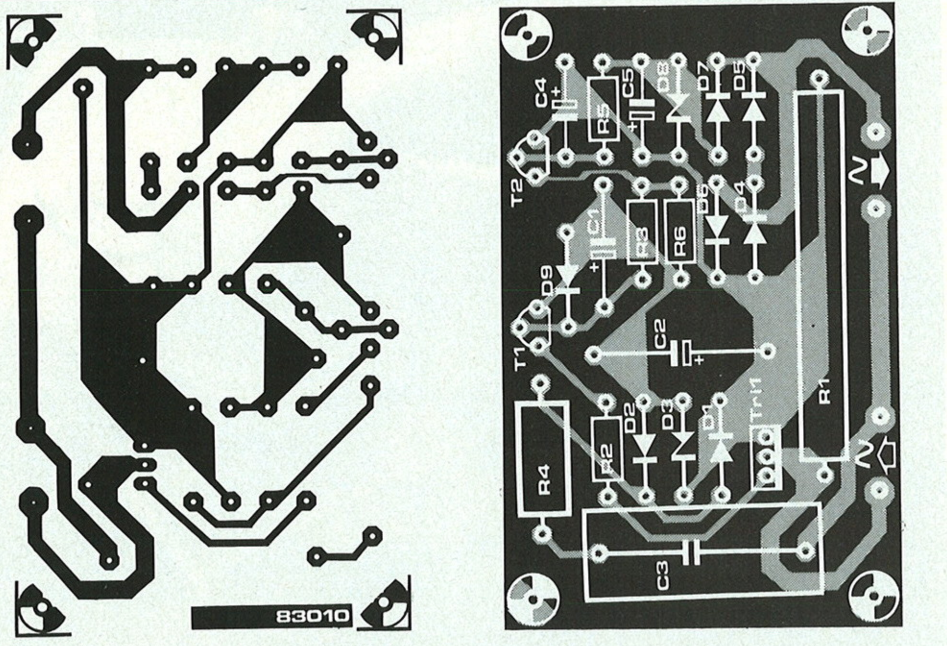


Figure 5. Track pattern and component overlay of the printed circuit board for the Fuse Protector. Input and output are at the same edge of the p.c.b. and must not be interchanged!

purely capacitive, so that only about 170 mW are accountable on the electricity bill! From this current flow, D1, D2, D3 and C2 produce a stabilised supply voltage of 4.7 V.

If no apparatus is switched on, there is no voltage drop across diodes D4 . . . D6. The result is: T2 is turned off, T1 is turned off and Tri1 is not provided with triggering current and is therefore also turned off.

When the apparatus is switched on, its starting current flows via R1 which limits it, thus preventing the type of surge discussed.

Simultaneously, however, this current flow results in a voltage across D4 . . . D6 which is rectified by D7 (germanium) and smoothed by C5. T2 then begins to conduct after a delay caused by R5 and C4. The result is that T1 is activated after a delay brought about by C1 and R3 and the triac is finally triggered. After these delays, the mains voltage is fully applied to the apparatus.

Application, installation, modification

The fuse protector can be simply utilised as an outboard unit. There is no need to modify the apparatus in question.

It is practical to install the printed circuit board with its components and a power socket in a well insulated housing, which can then be employed as a universal softstart unit.

The connected load must not exceed 660 VA. This somewhat restrictive limit is governed by the ratings of diodes D4 . . . D6. Diodes with higher ratings can be utilised but are not always easy to procure. A connected load of 1.3 kVA, for example, requires 6 A diodes and a type 216 TICD triac (with heatsink).

When using triacs other than the ones specified, their triggering characteristics must be taken into account; an equivalent triac must trigger reliably at 10 mA. ◼

Partslist

Resistors:
R1 = 150 Ω/9 W
R2 = 120 Ω
R3 = 47 k
R4 = 330 Ω/1 W
R5 = 220 k
R6 = 39 k

Capacitors:
C1 = 47 µ/16 V
C2 = 220 µ/16 V
C3 = 330 n/630 V
C4 = 10 µ/16 V
C5 = 1 µ/16 V

Semiconductors:
D1,D2 = 1N4001 . . . . 1N4007
D3 = 4V7/400 mW zener diode
D4 . . . D6 = 1N5401 . . . . 1N5407
D7 = DUG (AA 119, see text)
D8 = 2V7/0,4 W zener diode
T1 = BC 547 B
T2 = BC 557 B
Tri1 = TIC 206D (4 A),
TIC 216D (6 A),
TIC 225D (8 A)

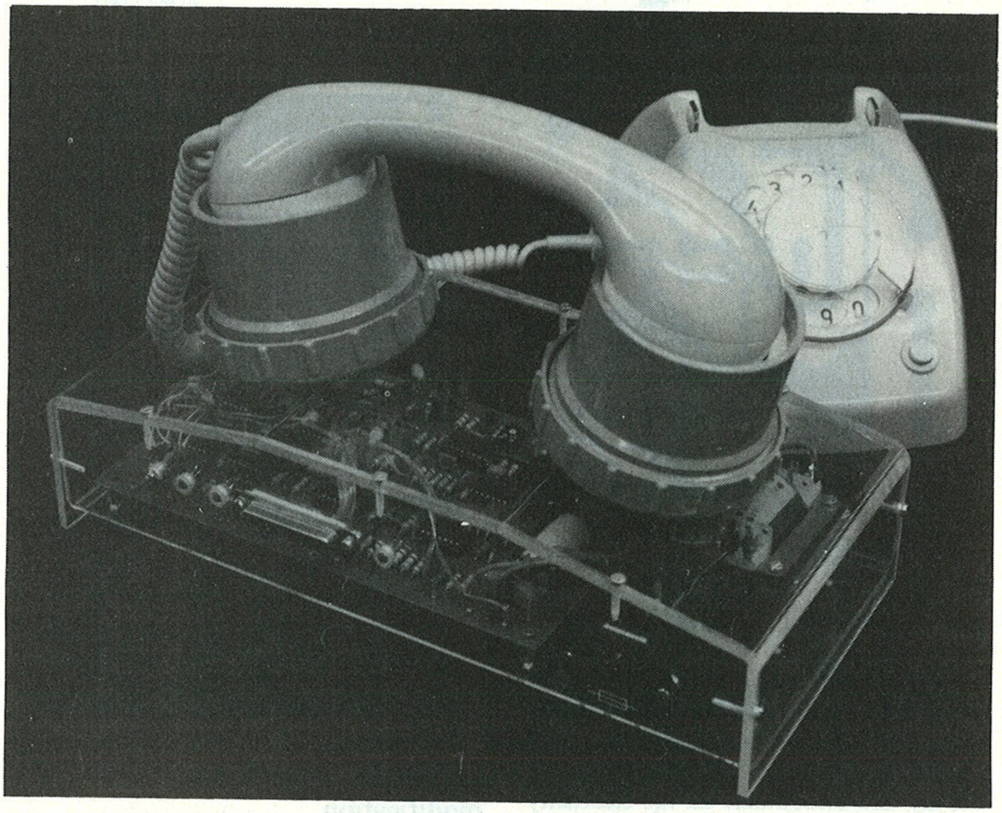
Miscellaneous:
Plastic case
Power socket

The modem described here is a circuit that is designed to send and receive digital information via the normal telephone lines. It enables the interconnection of two computers (or a terminal and a computer) even though they are physically separated by a large distance. The circuit provides a minimum data transfer rate of 600 Baud. The modem is compatible with an RS 232 interface and is acoustically coupled with the telephone receiver handset. A safety circuit is also incorporated to prevent the modem from switching to transmit during data reception.

acoustic telephone modem

data transfer via telephone lines

J.J.M. Habets and
C.A. Truijens



The term 'modem' is a contraction of the two words modulator and demodulator. At one end of the data transmission line (for us that usually means a telephone line) the digital information is transmitted in a modulated form and then demodulated at the other end to restore the original data.

The principle is illustrated in figure 1. Two matched modems are required to make a single data transmission line, one for each telephone. Each modem is able to transmit and receive (but not at the same time we hope!). If one modem is in the transmit mode, the modem at the other end of the line must obviously be switched to receive. The only existing limitation is that data traffic is possible in only one direction at a time.

Since it is not possible to connect any circuit directly to the telephone lines (a prospect that makes British Telecom go weak at the knees), we must resort to an acoustic coupler. This is not the awful disadvantage that may at first be presumed. The connection to the computer, or any peripheral, is by means of an RS 232 interface.

The modulation method used with the modem is that of frequency shift keying (FSK). This means that the digital information is translated into frequencies for transmission. In this case, frequencies of 1200 and 2200 Hz have been chosen – a logic '1' being represented by 1200 Hz and a logic '0' by 2200 Hz. FSK is ideal for this application since it is simple and relatively free from interference.

Modem basics

The principle of the circuit of the modem is illustrated in the block diagram of figure 2.

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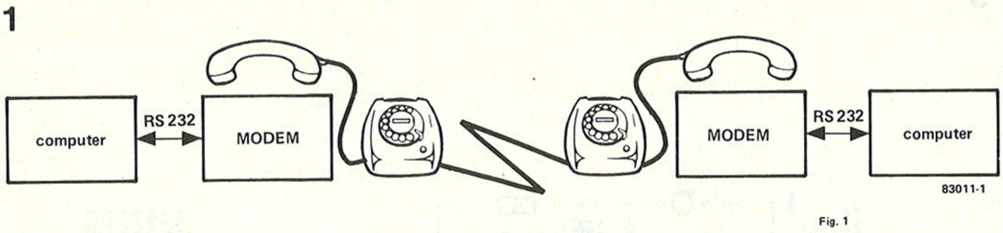

Figure 1. The use of a modem is illustrated in this drawing. Each modem can act as either a transmitter or as a receiver.

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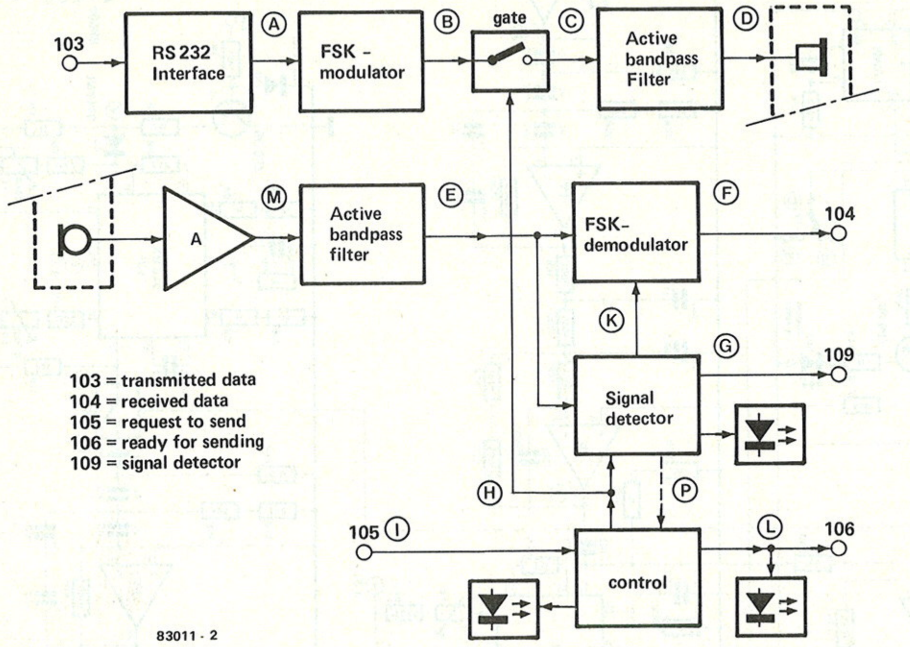

Figure 2. The separate stages of each modem are shown in this block diagram. The transmit section is at the top with the receive section in the centre and the control section at the bottom.

In the transmitting section the incoming digital data is passed via an RS 232 interface to the FSK modulator where the logic levels are converted into 1200 or 2200 Hz bursts. The output of the modulator is then fed via the gate to a bandpass filter that will pass the two FSK signals but will reject any higher harmonics. The acoustic coupling to the telephone handset for the transmit section is carried out by means of a small speaker, placed in close proximity to the microphone insert.

The acoustic coupling for the receive section of the modem is, as expected, a microphone placed over the earpiece of the handset. Again, a bandpass filter is employed to remove unwanted signals above the two FSK frequencies. The FSK demodulator then processes the information and restores the original data.

The two other blocks shown in the diagram, 'signal detector' and 'control', regulate the traffic flow in the modem. If a 'request to send' is made by the equipment connected to the modem, the control stage ensures that the signal detector has released the transmitter. If such is the case then, after a brief interval, the gate is activated enabling the output of the modem receive section. At the same time it gives a 'ready for sending' signal to the connected equipment so that transmission of the data can commence.

The signal detector checks to see if data is being received. As long as one of the two FSK signals is detected on the line the control block is prevented from switching in the modulator circuit. This effectively prevents transmission by the modem while data is being received.

The modem circuit diagram

The layout of the circuit diagram of the modem shown in figure 3 closely follows that of the block diagram. The upper section is the modulator, the centre section the demodulator while the signal detector and the control sections are to be found to the right and the left respectively of the lower part of the diagram.

The transmitted data arrives at the upper left-hand corner of the drawing at terminal 103. This terminal numbering is related to CCITT recommendation V24. If S1 is in position Q-R, T-M the requirements of this recommendation and that of the virtually identical EIA-RS 232 standards are met. The RS 232 interface consists of components T1, D1, R1 and R3. With an RS 232 interface a logic '0' is represented by a voltage level of between +5 and +15 V and a logic '1' by a level between −5 and −15 V. When a logic '1' present at terminal 103 transistor T1 will conduct to bring point A of the circuit down to about −10 V. With logic '0' at the input, point A will rise to 12 V. Diode D1 ensures that the base-emitter voltage of T1 does not exceed 0.6 V. With the levels thus

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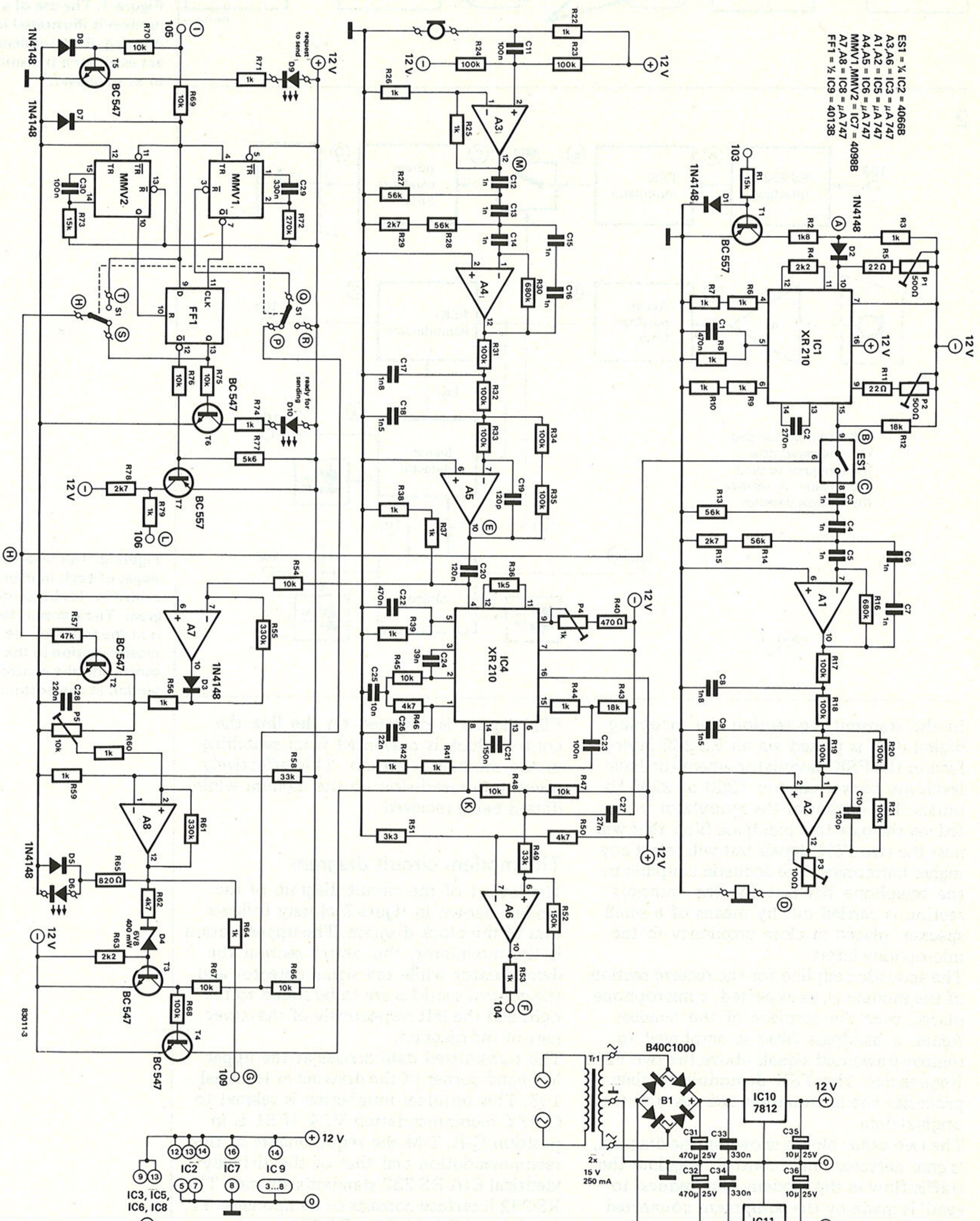


Figure 3. The layout of the circuit diagram here closely follows that of the block diagram in figure 2.

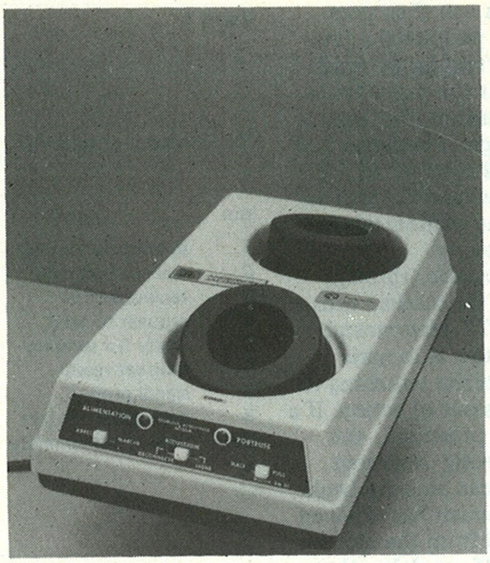
obtained at point A the FSK modulator – constructed with an XR 210 – can be driven. The IC is a phase-locked loop specifically designed for data communication applications, particularly FSK. Dimensioning of the components around the IC is such that a frequency of 2200 Hz is present on pin 15 with a voltage of −12 V on pin 10. With a voltage of −11 V or less (in this case about −10.5 V) on pin 10, pin 15 supplies a frequency of 1200 Hz. This means that the FSK modulator produces frequencies of 2200 Hz with a '0' and 1200 Hz with a '1' at input 103. The modulator is followed by the gate with which the connection between the modulator and the succeeding filter can be interrupted by the control section.

The active filter comprises a series circuit formed by third order high- and low-pass Butterworth filters. The crossover point of the high-pass filter is 1200 Hz and that of the low-pass filter 2200 Hz. The whole forms a bandpass filter accepting the two FSK frequencies only and attenuating the higher harmonics in the modulator output signal. The frequency characteristic of the bandpass filter is shown in figure 4. The output from the second filter section (A2) drives directly a small telephone receiver loudspeaker. The volume level can be adjusted within certain limits by P3.

The demodulator begins with a telephone receiver microphone capsule followed by the buffer/amplifier A3. Since the capsule contains a carbon microphone, it is connected to the positive supply voltage via resistor R22. A bandpass filter configured around A4 and A5 follows the amplifier, its function being to filter out interference caused by switching noise and cross-talk on the telephone line. The demodulator is also rendered less susceptible to environmental noises and vibrations caused by shocks on the modem housing. The filter construction is identical to that in the modulator part (around A1 and A2); the crossover points are also the same.

The FSK demodulator includes a second XR 210 (IC4); the demodulated signal is available on pin 8. R47, R48 and C27 again form a low-pass filter for this output, its purpose being to filter out small interfering impulses which may occur in the demodulator output signal. Finally, the Schmitt-trigger built up with A6 produces a well-defined digital signal with fast edges. The 'received data' can be fed to the connected computer or peripheral equipment via output 104. The output from A6 switches between + and −12 V so that RS 232 levels are directly available.

The signal detector comprises the section around A7, A8, T2, T3 and T4. The signal originating in the filter of the receiving stage is first limited while transistor T2 which follows switches off the limited signal when transmitting; in that case the detector is switched out. The limited signal passes via potentiometer P5 to a Schmitt-trigger with a switching hysteresis of about 150 mV (A8). The output from A8 supplies the detection signal (connection 109: data carrier detect) for the connected equipment (+12 V); A8 provides an RS 232-compatible



signal. If the circuit detects an incoming signal this is indicated by LED D6 (data carrier detect) lighting up. The signal detector can, by means of T3, short-circuit the demodulator output if transmitting.

The control circuit (the section around MMV1, MMV2 and FF1) regulates the exchange of traffic. If the interconnected equipment wishes to transmit it will present a 'request to send' signal (+12 V) at input 105; transistor T5 then causes LED D9 to light. In the position of S1 shown in the drawing, MMV1 will be triggered by the leading edge of the signal at input 105 (provided the signal detector doesn't detect a received signal; in which case MMV1 is blocked by T3 and nothing happens further). Following the MMV time of 45 ms its $\overline{Q}$ output becomes '1' again. The logic level at the D input of FF1 (the +12 V present at input 105) is at that moment transferred to the Q output of the flip-flop ($\overline{Q}$ thus becomes 0), with the result that LED D10 lights up (ready for sending), ES1 is activated and the signal detector blocked via T2. Output 106 supplies a 'ready for sending' signal (+12 V) to the connected equipment. Transmission

4

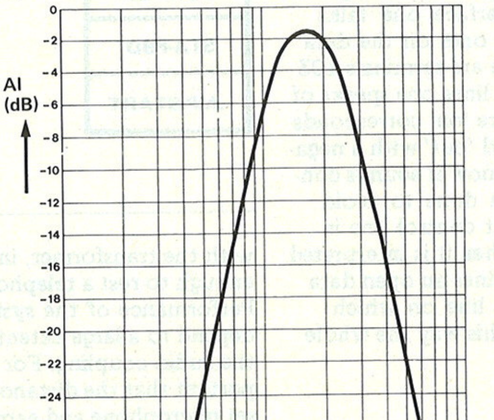


Figure 4. The frequency characteristics of the bandpass filters used in both the transmit and receive stages. The slopes are 18 dB/octave.

of the digital information can then commence. The computer or peripheral equipment must maintain the 'request to send' input at +12 V throughout the entire transmission period. After transmission, input 105 must be set at a voltage of between 0 to −12 V, with which MMV2 is triggered. This then resets FF1 so that the modulator is deactivated and the receiving section released by means of the signal detector.
If S1 is set to the other position (through-connections Q-P and H-S) the modem satisfies the guidelines of CCITT recommendation V24. In that case the automatic blocking facility which inhibits switching to transmit while receiving, is out of action. If a 'request to send' is then presented, the modulator section is directly activated. Information transmission can actually begin when the connected equipment has received a 'ready for sending' signal from the modem, in other words after the 45 ms delay time produced by MMV1. During the 45 ms, echo's caused by a signal on the telephone line are given time to decay. Figure 5 is a timing diagram of the different signals from the control section, intended to clarify its functioning. When building the modem as described later, it is not essential to include switch S1. If the intention is to use the modem in one manner only, two links on the printed circuit board will suffice.
Lastly, two integrated voltage regulators IC10 and IC11 stabilise the + and −12 V circuit voltage supplies.

Zero and One with RS 232/V24

In the course of this article we have mentioned that all the modem connections are V24/RS 232-compatible. Further explanation is necessary since the V24/RS 232/level interface definitions might appear somewhat confusing to someone not at home in this field.
A V24/RS 232 interface operates with positive and negative voltages, the negative voltage lying between −5 and −25 V and the positive between +5 and +25 V. The interface functions with negative logic, that is to say a binary '1' corresponds with a negative voltage and a '0' with a positive voltage. With a V24/RS 232 interface one talks actually about zeros and ones on the data lines (in the modem these are terminals 103 and 104). On the control lines one speaks of 'on' and 'out' states, where 'on' corresponds with a positive voltage and 'out' with a negative (or no) voltage. We know it sounds confusing, but this has been done to avoid faults. If namely an input control line is open or short-circuited, then it is interpreted as being 'out'. With data lines an open data input is interpreted as a line on which nothing has changed. In this way the whole is 'fail safe'.

The construction

The entire circuit can be assembled on the printed circuit board shown in figure 6. It will be apparent that, for a complete system, two printed circuit boards are necessary, one at each end of the telephone line. The completed circuit board is mounted, together with the transformer, in a case that is large enough to rest a telephone handset on. Performance of the system as a whole can depend to a large extent on the 'quality' of the audio coupling. For this reason it is important that the distance between the handset microphone and earpiece and the modem loudspeaker and microphone are kept as close together as possible. It is also necessary to keep out external noise as much as possible. One method would be to fit two short lengths of tubing (plastic drainpipe?) into the top of the case in such a way that the handset just fits in when it is laid on top of

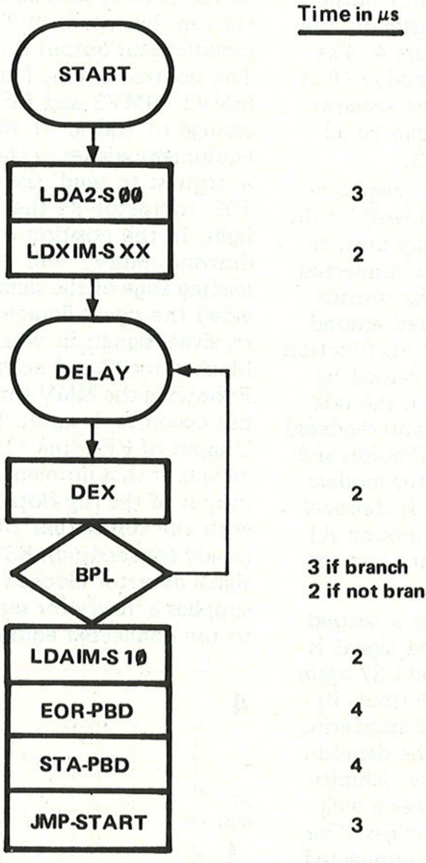
Table 1

To computer or terminal

pin	signal		pcb/CCITT
1	protective ground		
2	transmitted data	TMD	103
3	recieved data	RCD	104
4	request to send	RTS	105
5	ready for sending	RFS	106
6	data set ready	DSR	107
7	signal ground		gnd
8	data carrier detect	DCD	109
20	data terminal ready	DTR	108

Table 1. The wiring plan for the D connector.

Table 2



```
Address   Data
0200      A5 00
0202      A2 XXhex
0204      CA
0205      10 FD
0207      A9 10
0209      4D 82 1A
020C      8D 82 1A
020F      4C 00 02
```

$T = 44 + 10 \cdot XX_{dec}$

Table 2. This program enables the Junior Computer to be used when calibrating the modem.

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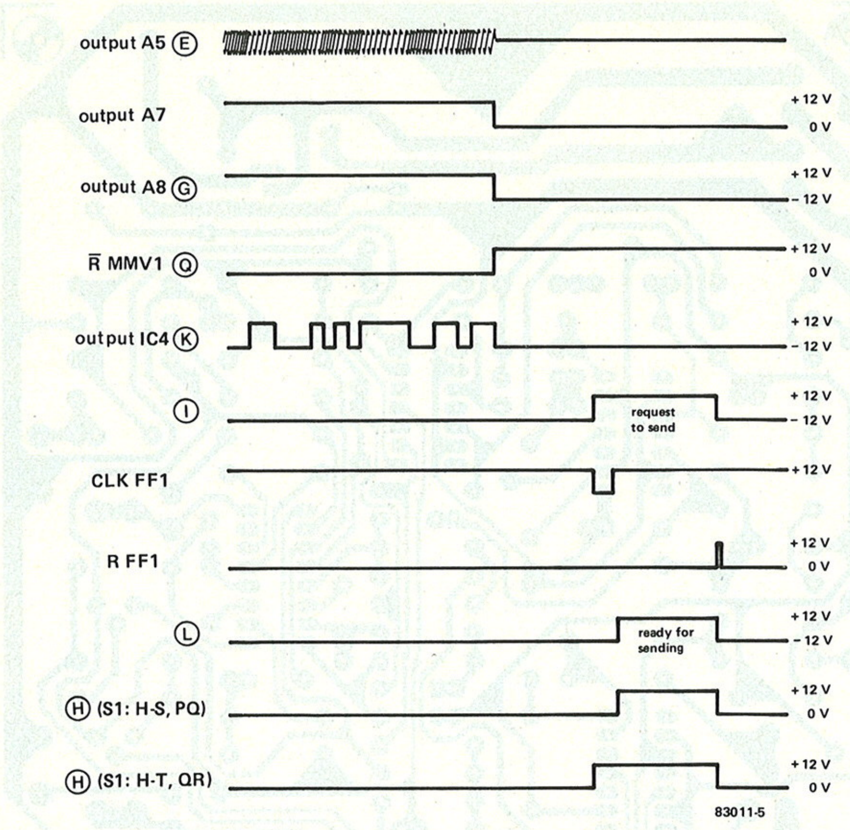


Figure 5. This waveform timing chart shows the different signals for the control section. The two waveforms for point H depend on the position of switch S1.

the case. The modem loudspeaker and microphone can then be mounted in the ends of the tubing. A ring of foam rubber (or draft excluder) glued around the lower end of the tube will complete the seal.

A surplus handset can supply the microphone and loudspeaker for the modem if this option is open. However, a higher quality microphone insert and loudspeaker would probably give better results. It is also possible to use a dynamic rather than a carbon microphone. In this case the amplification factor of A3 must be adjusted by increasing the value of resistor R25 to, for example, 100 k. Since a dynamic microphone does not need a dc voltage resistor R22 can be omitted.

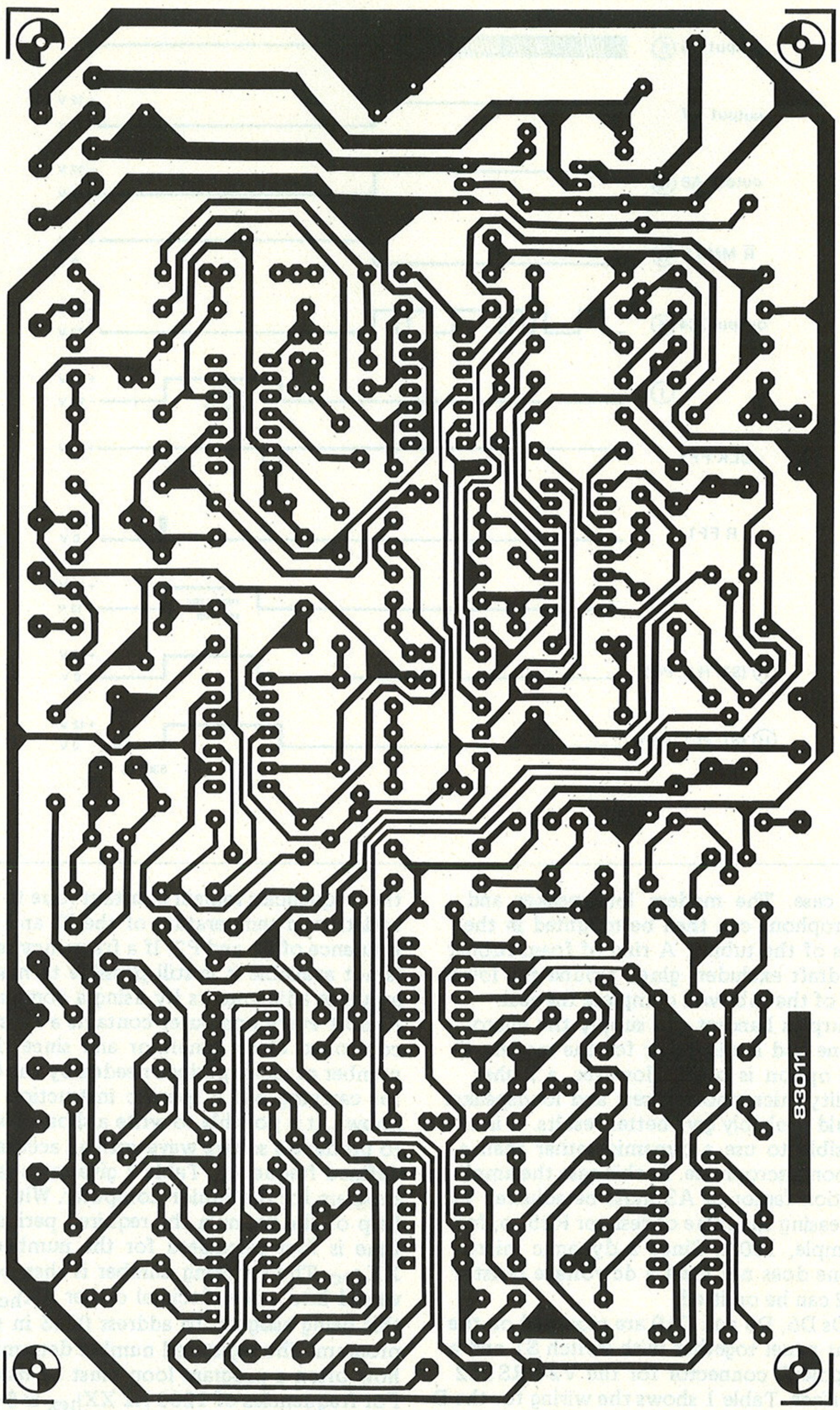
LEDs D6, D9 and D10 are mounted on the front panel together with switch S1 and a 25 pole D connector for the V24/RS 232 interface. Table 1 shows the wiring for the D connector.

Calibration

For initial calibration, terminal 105 on the printed circuit board is connected to +12 V. This will activate the modulator and produce a tone from the loudspeaker. LEDs D9 and D10 should also light. Terminal 103 is then connected to −12 V and the modulator will now produce a frequency of 1200 Hz. The frequency on pin 15 of IC1 is aligned exactly to 1200 Hz by P2 with the aid of a frequency meter. Terminal 103 is then connected to +12 V and the frequency on pin 15 adjusted to 2200 Hz with P1. These adjustments must be repeated a few times until the frequencies remain constant (due to the variation in temperature of the IC and the influence of P1 and P2. If a frequency meter is not available it is still possible to make accurate adjustments by using a computer. Almost every computer contains a crystal-controlled clock generator and since the number of clock periods needed by the CPU for carrying out a specific instruction is known, it is possible to write a short program to produce a square wave with an accurately defined frequency. Table 2 gives a suitable program for the Junior Computer. With the help of the formula the required periodic time is first calculated for the number XX_{dec}. The resulting number is then converted into a hexadecimal cipher XX_{hex}, this being assigned to address 0203 in the program. The registered number determines how often a program loop must be made. For frequencies of 1200 Hz XX_{hex} is $ 4F, for 2200 Hz $ 29 and for 1700 Hz (needed later) XX_{hex} is $ 37. In order to obtain the 1700 Hz as accurate as possible, the first instruction (A5 00) is omitted. All other instructions are then moved up two address places. The program starts on address 0200. The square wave is available at point PB4 of the computer.

With the aid of the frequency produced by the computer and the small circuit of figure 7 the modulator can then be aligned without a frequency meter. Point 1 of the circuit is connected to the computer output that supplies the 'reference frequency' – PB4 with the Junior – and point 2 is connected to pin 15 of IC1. A telephone earpiece or small

6



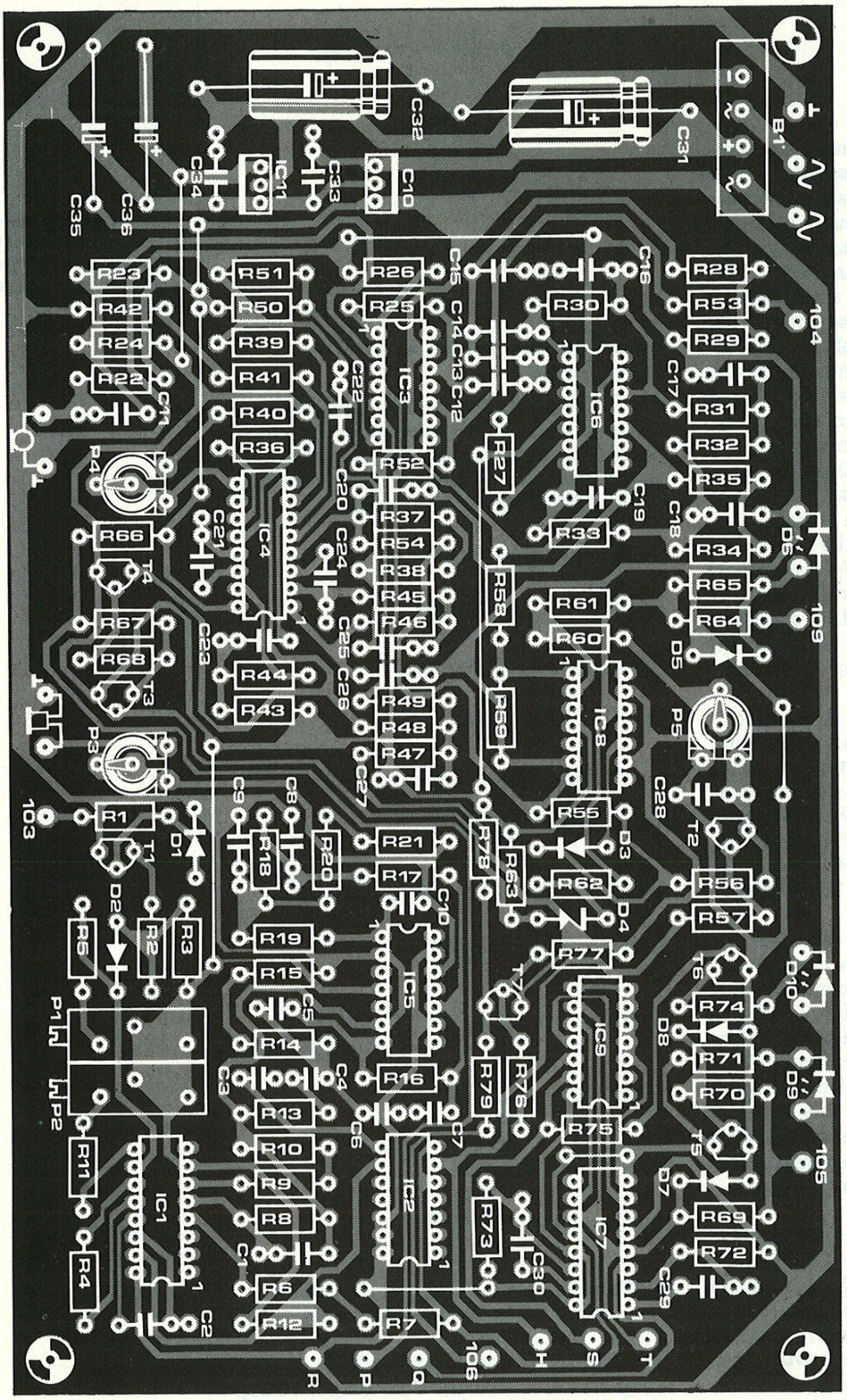
Parts list

Resistors:

R1,R73 = 15 k
R2 = 1k8
R3,R6 . . . R10,R22,R25, R26,R37 . . . R39,R41, R42,R44,R53,R56,R59, R60,R64,R71,R74, R79 = 1 k
R4,R63 = 2k2
R5,R11 = 22 Ω
R12,R43 = 18 k
R13,R14,R27,R28 = 56 k
R15,R29,R78 = 2k7
R16,R30 = 680 k
R17 . . . R21,R23,R24, R31 . . . R35, R68 = 100 k
R36 = 1k5
R40 = 470 Ω
R45,R47,R48,R54,R66, R67,R69,R70,R75, R76 = 10 k
R46,R50,R62 = 4k7
R49,R58 = 33 k
R51 = 3k3
R52 = 150 k
R55,R61 = 330 k
R57 = 47 k
R65 = 820 Ω
R72 = 270 k
R77 = 5k6
P1,P2 = 500 Ω 10 turns potentiometer
P3 = 100 Ω preset potentiometer
P4 = 1 k preset potentiometer
P5 = 10 k preset potentiometer

amplifier with loudspeaker is connected to the potentiometer wiper. Output 103 is now connected to −12 V, the 1200 Hz program started and we can listen to what the loudspeaker produces. Three different frequencies are audible: the 1200 Hz from the computer, the modulator frequency and the difference between these two frequencies. The 50 k potentiometer is adjusted so that the difference frequency can be heard as clearly as possible. P2 is then rotated until the volume of the difference frequency is as low as possible. The modulator frequency is then virtually equal to the 'reference frequency'. The same procedure is then repeated with connection 103 at +12 V and the computer program for 2200 Hz; adjustment takes place with P1. Point 105 is then disconnected from +12 V.

For adjusting the demodulator a frequency meter is connected to pin 15 of IC4; P4 is then turned so that the frequency at this point is exactly 1700 Hz. The computer can again be used here with the program for 1700 Hz (see table 2). This frequency again passes to point 1 of the auxiliary circuit and



Capacitors:
C1,C22 = 470 n MKT
C2 = 270 n MKT
C3 . . . C7 = 1 n ceramic
C8,C17 = 1n8 MKT
C9,C18 = 1n5 MKT
C10,C19 = 120 p ceramic
C11,C23,
C30 = 100 n MKT
C12 . . . C16 = 1 n MKT
C20 = 120 n MKT
C21 = 150 n MKT
C24 = 39 n MKT
C25 = 10 n MKT
C26 = 22 n MKT
C27 = 27 n MKT
C28 = 220 n MKT
C29,C33,
C34 = 330 n MKT
C31,C32 = 470 μ/25 V
C35,C36 = 10 μ/25 V

Semiconductors:
D1 . . . D3,D5,D7,
D8 = 1N4148
D4 = zener 6V8/400 mW
D6,D9,D10 = LED red
T1,T7 = BC 557
T2 . . . T6 = BC 547
IC1,IC4 = XR 210
IC2 = 4066B
IC3,IC5,IC6,IC8 = 747
IC7 = 4098B
IC9 = 4013B
IC10 = 7812
IC11 = 7912
B1 = B40C1000

Miscellaneous:
Tr1 = transformer
2 x 15 V/250 mA
1 loudspeaker capsule
1 microphone capsule
from telephone receiver

point 2 is connected to pin 15 of IC4. P4 is then aligned to a minimum difference frequency.

For adjusting the signal detector a tone must be supplied to the microphone. For this purpose another modem can be utilised whose loudspeaker is coupled to the microphone of the other modem. Terminal 105 of the 'transmitting' modem is connected to +12 V. If only one modem is available the loudspeaker can be temporarily removed from its normal position and rested on the microphone. Terminal 105 is then connected to −12 V and IC2 temporarily removed from its base. Pins 8 and 9 in the vacant base are then bridged with a wire link. P5 must then be adjusted so that LED D6 lights when the spacing between the loudspeaker and the microphone is such that 1 V is measured across P5. If the loudspeaker is removed the LED must extinguish. The loudspeaker volume can be varied slightly with P6, however this adjustment is not critical. The alignment of P5 needs to be checked again in practice since incorrect adjustment of the signal detector can result in the transmit section being released and the data output short circuited, while in reality data is being received.

The modem in use

This modem is primarily intended for communication between two personal computers so that programs can be exchanged by telephone. In that case the automatic blocking possibility is not absolutely necessary, so that the position of S1 is immaterial. This switch can thus be left out as we have already seen. For personal use not all the printed circuit board terminals are necessary. Terminals 103 (for transmission of data) and 104 (for data reception) are, in principle, sufficient. It is important moreover, that terminal 105 be used in the correct manner. If data is to be received a voltage of −12 V (or zero) must be at this point; for transmission pin 105 must be at a voltage of +12 V. If this is not the case the modem will not switch over from receive to transmit. It is possible to let the computer give these signals but it can, of course, be done manually by means of a switch, where terminal 105 can be connected to +12 V or −12 V according to choice.

On giving a 'request to send' signal it is necessary to reflect that terminal 106 will give a 'ready for sending' signal only after 45 ms; the computer can thus commence transmitting after the 45 ms. Furthermore it is necessary to ensure that nothing more is received (terminal 109 must be 'out') otherwise the demodulator will be switched off while data is still coming in.

The modem described here is intended for half duplex use so that signals can be received and sent, however not simultaneously. It is possible to adapt the modem for duplex use, simply by removing transistor T2. The frequencies must also then be chosen for duplex traffic. The relevant calculations are given at the end of the article. The minimum speed at which data can be sent and received is 600 Baud. Higher speeds are possible depending on adjustment accuracy, up to a maximum of 1200 Baud.

The quality of the telephone connection is very important. A reasonable 1200 Baud connection is possible for local use, although completely faultless transfer of large quantities of data can not be expected. On longer distance telephone connections or via small exchanges it is better to choose slower speeds. Interference on the telephone lines is prevented from reaching the demodulator by the filters as far as possible, but a noisy telephone line definitely produces faulty bits. Above all computers with a simple receiving routine will have this problem. The reliability increases as the Baud rate is lowered. A transmission speed of 600 Baud or less is thus preferable. Before transmitting data the telephone connection should be checked for sound quality. A weak connection or noise invariably entails breaking the connection and trying again. It is infinitely better to dial a few times more rather than have a data block full of faults; the latter certainly costs much more time!

7

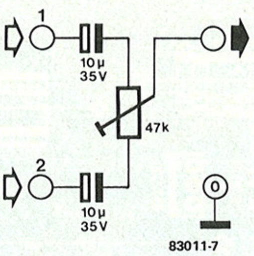


Figure 7. The small auxiliary circuit shown here is necessary only if the aid of a computer is enlisted for calibration purposes.

Modifications for alternative frequencies

For different applications it may be necessary to alter the FSK frequencies; this is quite possible by changing some of the component values. For the modulator (IC1) the following FSK frequencies are valid:

(a) for the lowest frequency:

$$f_l = \frac{220}{C2} \cdot \left(1 + \frac{0.1}{R11 + P2}\right)$$

(b) for the highest frequency:

$$f_h = f_l \cdot \left(1 + \frac{0.3}{R5 + P1}\right)$$

(c) The filters must also be modified:

$$R13 = R27 = \frac{0.06484}{f_l \cdot C}$$

(d) $R14 + R15 = R28 + R29 = \frac{0.07547}{f_l \cdot C}$

(e) $R16 = R30 = \frac{0.8239}{f_l \cdot C}$

(f) Where C = C3 = C4 = C5 = C6 = C7 = C12 = C13 = C14 = C15 = C16.

(g) $C8 = C17 = \frac{0.3908}{f_h \cdot R}$

(h) $C9 = C18 = \frac{0.3356}{f_h \cdot R}$

(i) $C10 = C19 = \frac{0.03073}{f_h \cdot R}$

(j) Where R = R17 = R18 = R19 = R20 = R21 = R31 = R32 = R33 = R34 = R35.

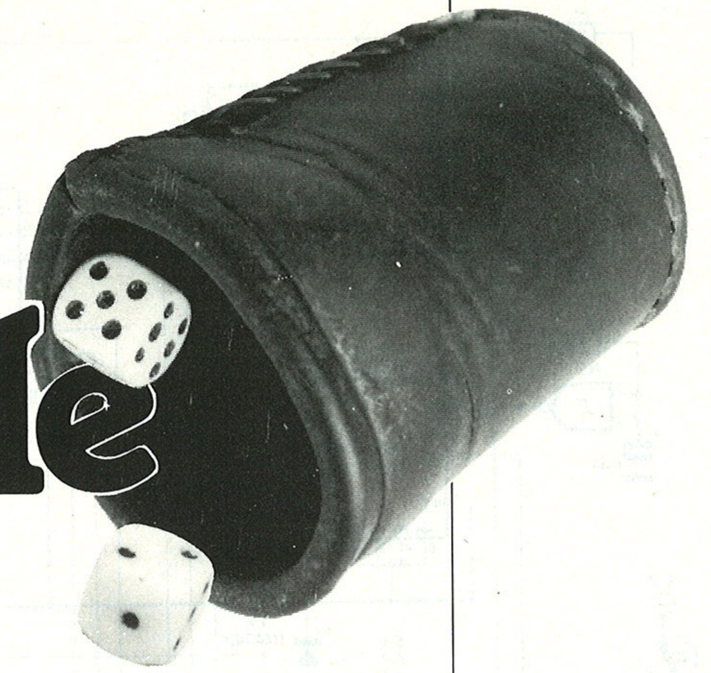
(k) With the demodulator the VCO of IC4 is adjusted such that the VCO on pin 15 supplies a frequency that lies between the FSK frequencies if the VCO is free-running (no input signal). This frequency is determined by the values of C21, R40 and P4:

$$f_{middle} = \frac{f_l + f_h}{2} = \frac{220}{C21} \cdot \left(1 + \frac{0.1}{R40 + P4}\right)$$

(l) In view of the fact that large tolerances occur with the PLL ICs it can happen that with a precalculated value a specific frequency cannot be set with the associated potentiometer. In such cases the values of the frequency determining capacitors (C2 with IC1 and C21 with IC4) must be modified. ◀

more spots before the eyes

double dice



After the 'Talking Dice' published in the November issue it could be considered that we have just about gone as far as we can go with respect to electronic dice. But no, we now have the 'non-talking double dice' which, if nothing else, is self explanatory! It is not totally dumb however, the score is shown on an LED display as either a single or a double dice, that is, a maximum count of six or twelve. It can even show when a double has been thrown!

The Talking Dice published recently created quite a lot of interest and a great many readers suddenly found themselves 'into' electronic dice. Paradoxically however, the next request was for a 'silent' dice! The reasons for this are not entirely clear but anyway, here we go!
It was considered that the dice must be easy to read but the use of LEDs in the pattern of a dice was 'old hat'. This only leaves seven segment displays but that is not such a bad idea. The following points were also considered to be essential.

a. The circuit must be able to operate as a single or a double dice.
b. It should be easy to use and always accurate.
c. The dice must of course be completely random and not prone to 'favourable' repeats.
d. Indication of a double would be a distinct advantage.

1

B \ A	1	2	3	4	5	6
1	2	3	4	5	6	7
2	3	4	5	6	7	8
3	4	5	6	7	8	9
4	5	6	7	8	9	10
5	6	7	8	9	10	11
6	7	8	9	10	11	12

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Figure 1. This table illustrates the total number of combinations possible with two dice.

2

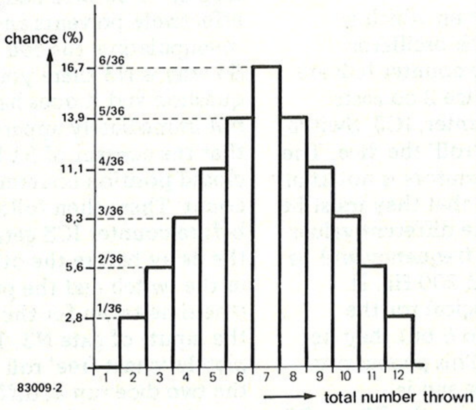


Figure 2. A histogram of the probability factor in percentages of any combination actually occurring.

The possible number of 'thrown' combinations of two dice comes to a total of 36 as shown in figure 1. However, the possibility of some numbers occurring more frequently exists. For example, double 1 (snakes eyes to the poker players) is far more difficult to find than say, a seven. Double 1 will only occur as 1 + 1 whereas 7 can arrive as 1 + 6, 6 + 1, 2 + 5, 5 + 2, 3 + 4

3

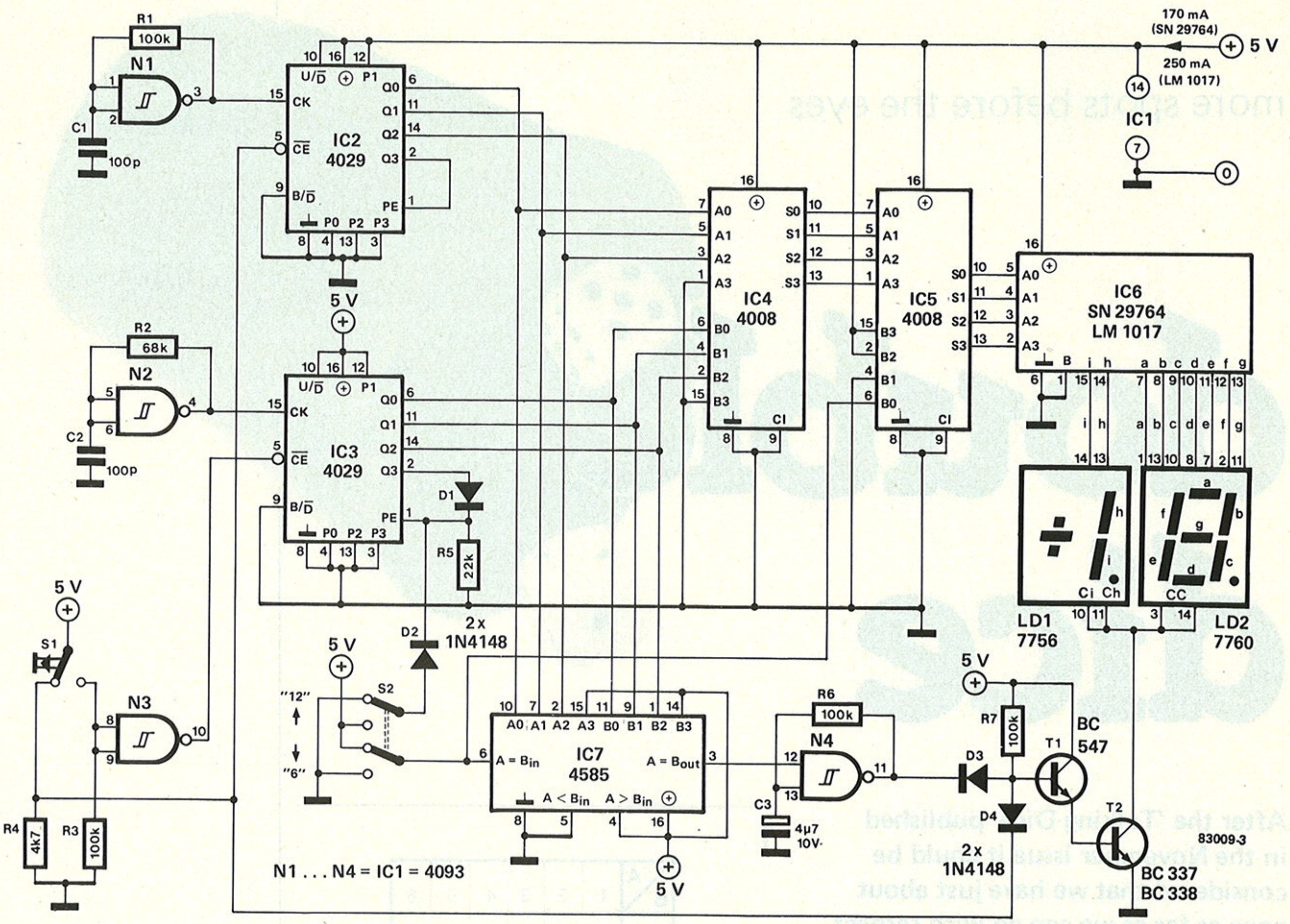


Figure 3. The complete circuit diagram of the double dice. The two part numbers for IC6 are explained in the text.

and 4 + 3. When the possibilities of 'random occurrencies' is expressed as a percentage it will be found that double 1 is only a 2.8% probability against a 16.7% probability factor for number 7. This is illustrated in figure 2 (forgetting the higher orders of Murphy's Law).

On now to the circuit diagram which is shown in figure 3. The clock oscillator formed by gate N1 and the counter IC2 are the basis for dice 1 while dice 2 consists of oscillator N2 and its counter, IC3. Switch S1 triggers the counter or 'roll' the dice. The frequency of the clock generators is not at all critical apart from the fact that they must be different, guaranteed by the different values for R1 and R2. The actual frequency will be somewhere between 50 and 200 Hz. It would at first sight seem logical for the counters to count from 1 to 6 but they do in fact count from 2 to 7. This peculiarity makes things a little simpler and is accomplished by programming the P0 . . . P3 inputs of the counters. In effect, when the count reaches 7 the Q3 output will go high and reset the counter. The P1 programming input is held at logic 1 while the others, P0, P2 and P3, are at logic 0 to result in a program code of 0010 which is BCD for 2 – but you already knew that! So, the counter counts between 2 and 7 but only when the C̄Ē (count enable) input is at logic 0, helped along by switch S1 and N3.

When counting, the outputs of the counters are as shown in figure 4. The top waveform (CK) is the output of the clock oscillator N1 or N2.

During the time that S1 is operated the base of transistor T1 is held low causing the display to be switched off by T2. This effectively prevents any possibility of 'manipulating' the roll of the dice.

So why is N3 there you may ask. A good question and it does have a purpose that is not immediately apparent. At the instant that the contact of S1 leaves its normally closed position counter IC2 will start to count. There then follows a finite time before counter IC3 gets under way due to the delay before the other contact is made in the switch and the propagation delay (the time taken for the output to react to the input) of gate N3. This ensures a completely 'cheat-free' roll since not only do the two dice run at different frequencies but also start and stop at different times. Our learned reader will now confidently suggest that the same time delay will occur when the switch is released therefore cancelling the difference out! But it won't and we leave it to you to figure out why not. All very cunning really!

A good point at which to move on to the other switch, S2, whose purpose, as suggested in the circuit diagram, differentiates between a one or two dice operation, that is, a maximum count of six or twelve. The outputs of both counters is fed to IC4 which, since it is a 4 bit adder, logically (?) adds them together. The output of IC4 is still not ready to display yet because we arranged the counters to count between 2 and 7! It seemed like a good idea at the time but it would not be Monopoly to have a set of dice (even if they were electronic) that came up with numbers like 13 and 14. Very trendy but we have to do something about it. In fact, it's IC5 that does something about it. The outputs of IC4 are fed to the A inputs of IC5 which then carries out some rather quick calculations with the 12 (1100) or 13 (1101) programmed on the B inputs and comes up with the answers shown in tables 1 and 2. This explains the link between switch S2 and the B0 input of IC5, it selects either 1100 or 1101. We are still not entirely out of the wood because, as the tables show, IC6 must still add 1 to the output of IC5 before the correct number can be displayed. However, it does get there in the end!

IC7 rejoices in the grand title of 4 bit magnitude comparator but it could almost be called a 'double detector' since that is it's function in life in this circuit. It simply looks at the two sets of inputs, A0 . . . A3 and B0 . . . B3, and produces an output when they are equal. This is called A = B output, of course, and when it goes high the oscillator formed by N4, R6 and C3 will switch the display on and off with a little help from transistors T1 and T2. A flashing display therefore signifies that a double has been thrown. All very swish but it would be most unseemly if it were to happen when only one dice is thrown. The paradox is prevented by switch S2 which takes the A = B input low when in the single dice, or '6' position. This effectively puts a black hood over IC7 and prevents it from 'seeing double'!

The power supply for the circuit consists of the usual 7805 regulator, probably the most useful IC ever invented. Only one other item worthy of note is left. The SN 29764 is pin compatible with the LM 1017, the only difference being current consumption. This is 170 mA for the former and 250 mA for the latter. It might be advisable to look for the SN 29764 since it is a little easier to find – especially from Anglia Components. ◾

4

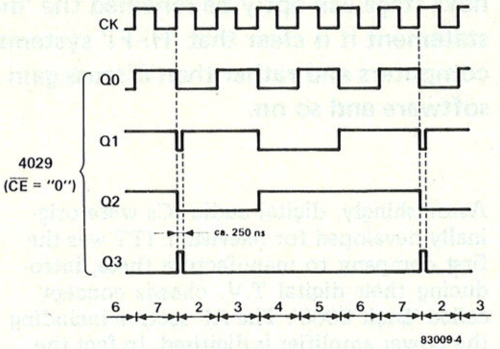


Figure 4. The waveforms for the Q outputs of the 4049 counters. The top pulse train (CK) is the output of the clock oscillators, N1 or N2.

Table 1

single dice

number thrown	output IC2	output IC3	output IC4	output IC5 (+12)	display
1	2	2	4	0	1
2	3	2	5	1	2
3	4	2	6	2	3
4	5	2	7	3	4
5	6	2	8	4	5
6	7	2	9	5	6

5

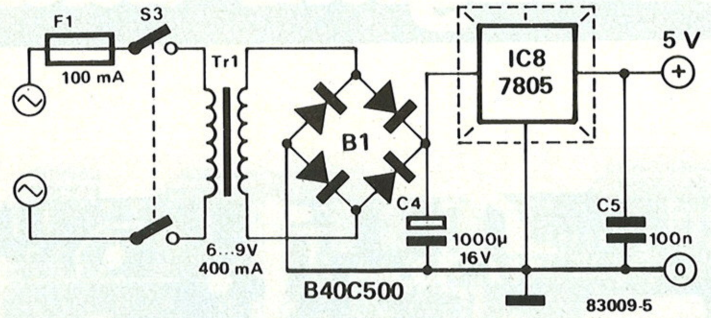


Figure 5. The power supply shown here will be more than adequate for the double dice. Remember to provide the regulator with a heatsink.

Table 2

double dice

number thrown	output IC4	output IC5 (+13)	display
2	4	1	2
3	5	2	3
4	6	3	4
5	7	4	5
6	8	5	6
7	9	6	7
8	10	7	8
9	11	8	9
10	12	9	10
11	13	10	11
12	14	11	12

chips for digital audio

part II

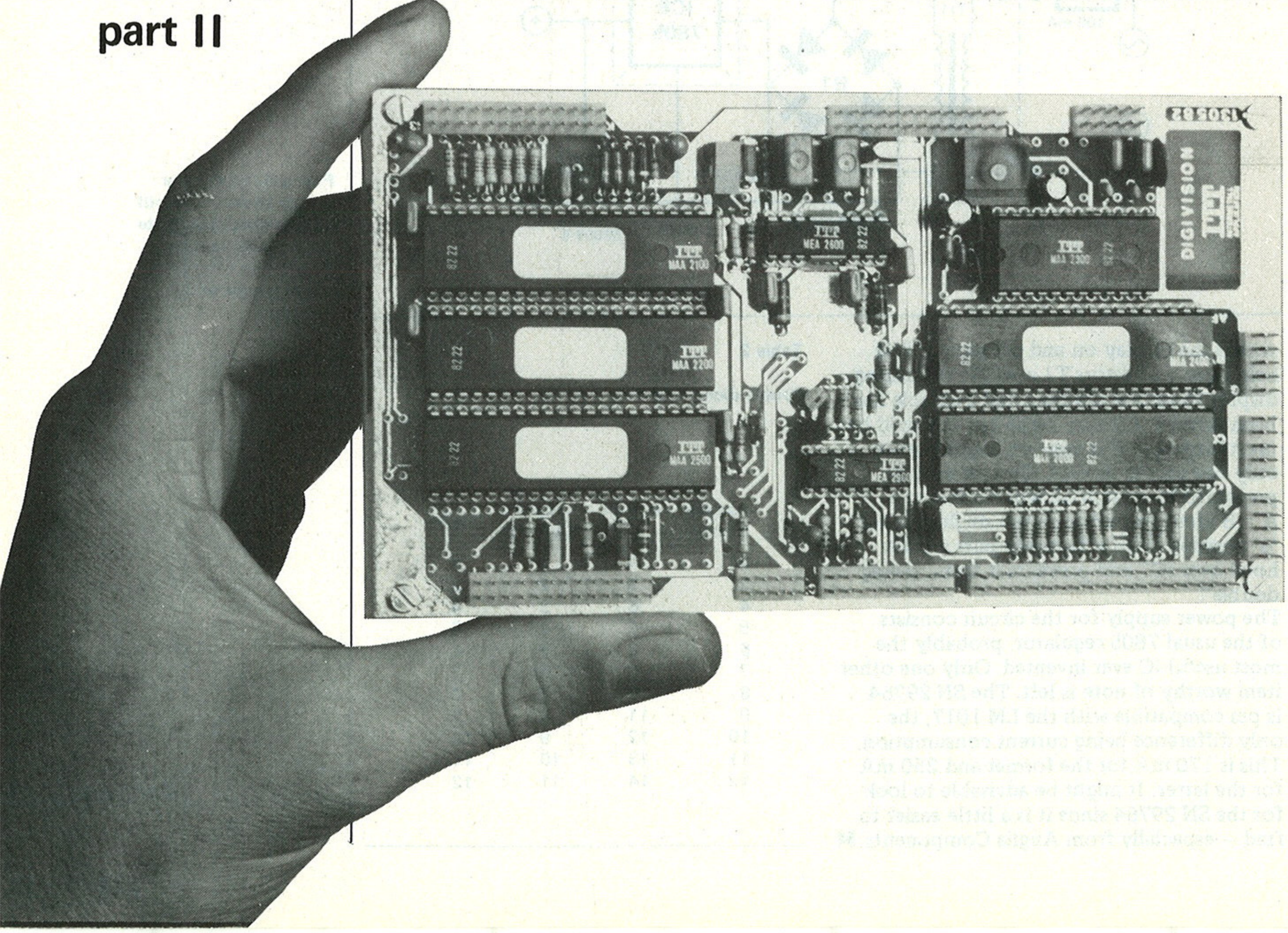
Last month's article concerning digital audio dealt with signal sources such as the compact disc. With the advent of digital pre-amp and control-amp IC's, the next stage can aptly be renamed the 'digital audio processor'. From this statement it is clear that 'Hi-Fi' systems of the future will look more like micro-computers and rather than discuss gain and feedback we will talk about time, software and so on.

digital audio in the T.V. set

Astonishingly, digital audio ICs were originally developed for television. ITT was the first company to manufacture these, introducing their digital T.V. chassis concept called 'Digit 2000'. The AF section including the power amplifier is digitised. In fact the complete audio processing stage including the stereo decoder (for stereo T.V. sound) consists of two chips! The digital to analogue converter is the MAA 2300 and the signal processor the MAA 2400.

The main thought in mind which prompted the research was to bring down the production costs, with the obvious price advantages to the consumer. Using the chips already developed for the compact disc would not have helped as they were very expensive, and anyway the production cost priorities are not the same as in the 'Hi-Fi' field. Or at least the thinking is relatively different. These two new chips are extremely versatile and can be used in many aspects of the audio field. They can be termed as the first born in the new family of digital audio processors.

Figure 1 shows the block diagram of the MAA 2300. The two analogue input signals are not digitised here by a 'real' binary encoding A/D converter, but by 1-bit quantizers in sigma-delta modulators (pulse density modulators). These emit a 1-bit data stream with a maximum rate of 4 MHz (4 Mbit/s); the digital filter which follows turns them into data words of 16 bits in length and a rate of 35 kHz. This method has already been well-proven with analogue-to-digital converters for the telecommunications field (codecs for the digital telephone). Steep-slope filters at the input (to limit the signal bandwidth) can be



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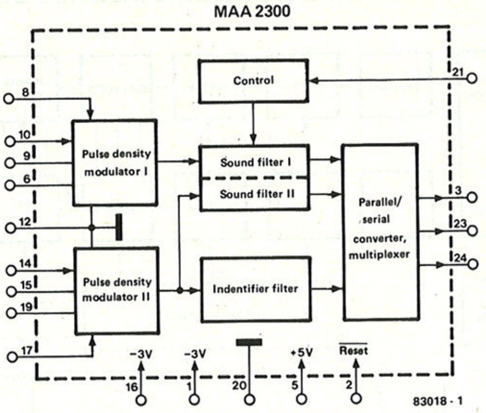

Figure 1. Block diagram of the MAA 2300 audio A/D converter from Intermetall. It is designed for converting two audio channels and delivers serial 16-bit data words at its output, with a word rate of 35 kHz per channel. The signal-to-noise ratio is comparable to that of a conventional 13-bit A/D converter.

2

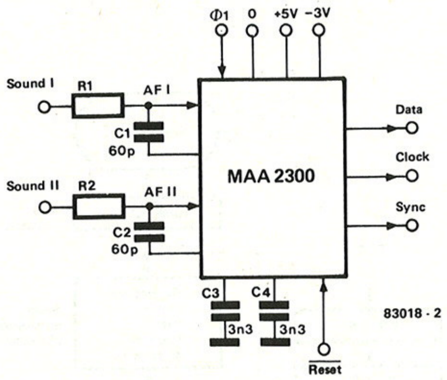

Figure 2. Application circuit of the MAA 2300. Input filters are not usually required on account of the high sampling rate of the pulse density modulators.

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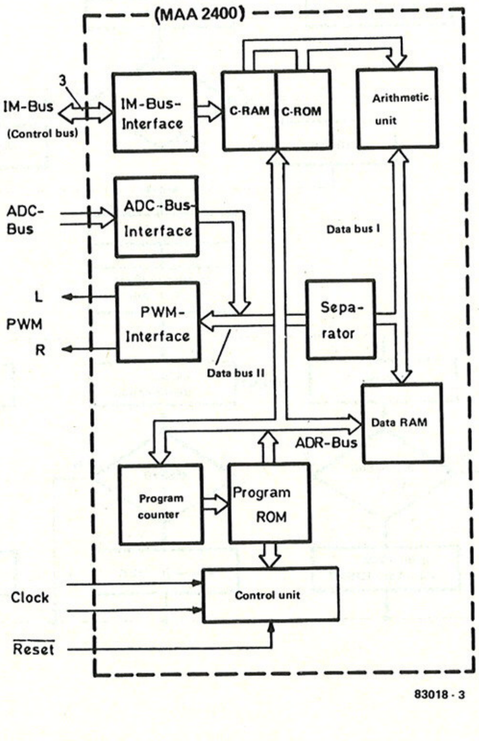


Figure 3. Block diagram of the MAA 2400 digital two-channel audio processor. The hardware structure is reminiscent of that of single-chip microcomputers.

dispensed with, thanks to the very high sampling rate of the sigma-delta modulators. The signal-to-noise ratio achieved by this analogue-to-digital converter approximately corresponds to that of a conventional 13-bit A/D converter.

The MAA 2300 also contains digital identifier filters which filter out the amplitude-modulated identifier from the sound signal of channel II. In the case of the stereo TV sound method introduced by a TV network in West Germany, these identifier signals are inaudibly superposed on the channel II sound signal and indicate whether the station being received is transmitting mono, stereo or two-channel sound. The identifier signal is also reduced digitally to a low bit rate.

Three signals are present at the output of the A/D converter: the data which are transmitted serially and which cyclically contain sound I (16 bits), sound II (16 bits) and identifier (10 + 1 bit), the 4 MHz clock signal and a 32 kHz synchronizing signal as the shift clock rate at which the data are transmitted synchronously. Figure 2 shows the application circuit of the A/D converter. Present at the inputs are: Sound I and sound II which, when free from DC, are connected via resistors for level adjustment, Ø1 a clock input for the clock signal from a 17.7 MHz clock generator (IC type MEA 2600) and, finally, a reset input.

The MAA 2300 is also suitable for normal stereo applications; in that case the identifier data are superfluous.

The MAA 2400 digital audio processor is designed for processing the audio and identifier data provided by the MAA 2300. As far as we are aware, this chip is the first digital audio processor in one IC. The IC executes a large number of digital processes at high speed; a detailed description would extend beyond the scope of this article. Basically, however, this IC resembles a 1-chip microcomputer which contains special interface and peripheral modules. The block diagram in figure 3 shows the hardware structure of the chip. It would be difficult to guess that this is an audio chip. The processing functions are specified in the program ROM by software. The IC can be very rapidly converted to different functions during production, by changing the program mask. With the ROM program supplied by ITT for TV applications, the user also has the facility for modifying basic functions via a serial bus input. The functions of the standard ROM are shown in figure 4, which also represents the hardware interfaces in addition to the software blocks. This time it is quite easy to guess that the device is an audio chip.

The following functions could just as easily be found in the block diagram of an analogue audio-frequency IC: matrix decoding, de-emphasis, linear volume adjustment, loudness adjustment, treble and bass adjustment, balance adjustment, stereo base width adjustment, pseudo-stereo circuit. These are all familiar features, in spite of the fact that they are all incorporated in one special single-chip microprocessor. An innovation, however, is that this chip does

4

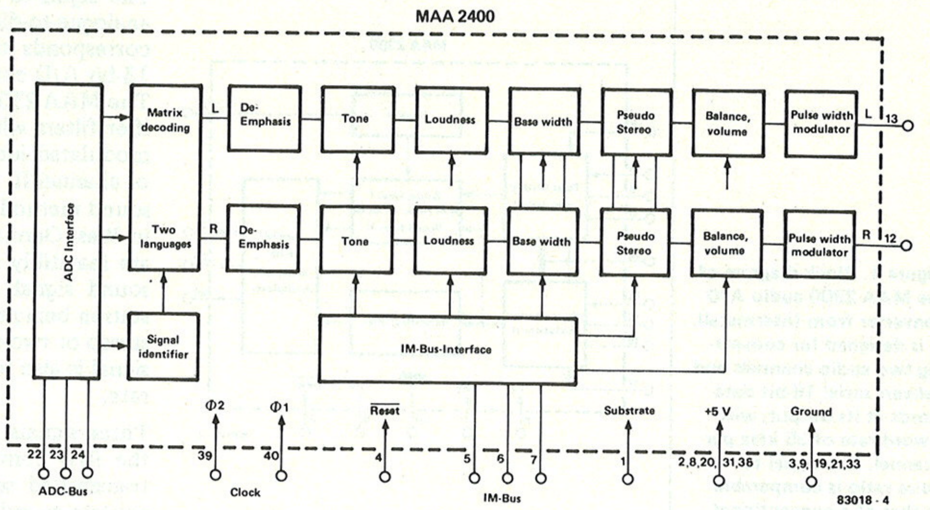


Figure 4. The functions of the audio processor are apparent in this block diagram, which contains the software blocks and hardware interfaces (marked *).

5a

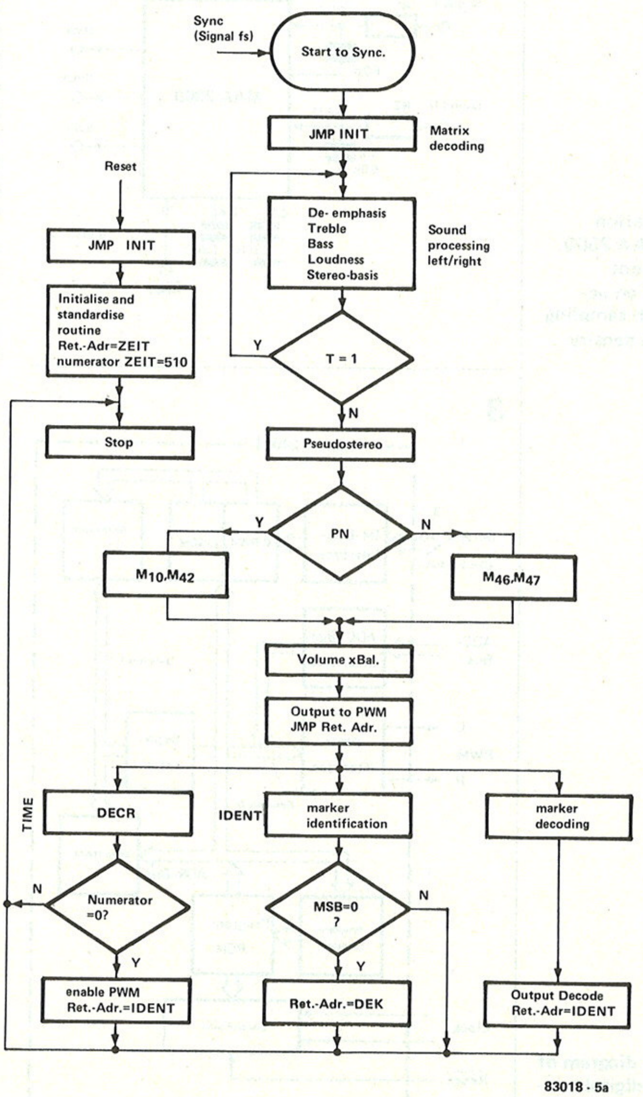


Figure 5a. The flowchart shows the program structure of the audio processor.

5b

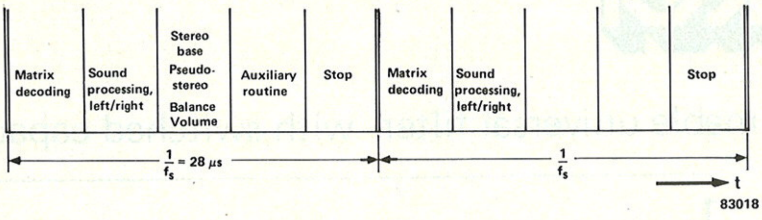


Figure 5b. Program timing: only 28 μs are available for each run consisting of several hundred operations.

6a

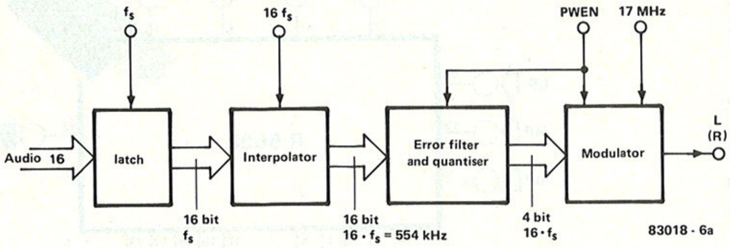


Figure 6a. Block diagram of one of the two PWM interfaces at the output of the audio processor.

6b

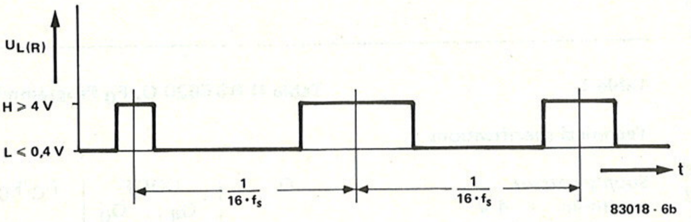


Figure 6. Pulse-width-modulated output signal of the digital audio processor. This allows switching output stages to be driven, as well as conventional analogue amplifiers after lowpass filtering (integration).

not present digital or analogue audio signals at its outputs, but pulse-width-modulated signals. Instead of the usual D/A converters, digital/PWM converters are used here to allow direct driving of switching output stages. By means of simple lowpass filtering (integration) of the PWM signals, analogue ouputs are also obtained for driving conventional amplifiers. The arithmetic operations for implementation of these functions are obviously complex. Most of the functions are implemented by digital filtering. One simple filtering function, for example, requires three multiplications and one addition of three addends. The basic operations for filter systems are 'multiplication + adding/subtracting'. For a simple highpass filter, three such basic operations must be executed together with the corresponding data transfer, within a sampling period of 28 μs. When being processed in the MAA 2400, the digital audio signals are subjected to about 100 such operations, so that each individual basic operation must take place in less than 280 ns. The program ROM must deliver commands at extremely high speed: at intervals of 56 ns.

The flowchart in figure 5a shows the program of the MAA 2400. After activation, the processor is initialized by a reset. Then comes a 'stop'. A program run starts with the sampling clock signal (sync) from the MAA 2300 A/D converter. Branching to various routines takes place at the end of the main program. A time loop is processed after the system start. In normal operation the IDENT routine looks for valid identifier data which are then evaluated in the identifier decoding routine in the next program run. The timing diagram of figure 5b shows the timing of the program run. Only 28 μs are available for one program run, i.e. 32,000 runs per second allowing a maximum of 4 million data bits to be processed.

Figure 6 shows the block diagram of one of the two identical PWM interfaces. The processed audio information of the channel is presented in 16-bit words with a sampling frequency of 35 kHz. The input latch is followed by an interpolator (for intermediate values) which increases the sampling number by a factor of 32. After this oversampling with a factor of 32, the 16-bit samples arrive from the interpolator at a sampling frequency of 554 kHz. A drastic process takes place at this stage: of the 16-bit words, only four bits are left over and are converted to a 554 kHz PWM signal by the modulator. The remaining, truncated 12 bits per sample are not discarded but fed back for correction. With the Philips D/A converter this is known as noise shaping; this process serves the same purpose here. The next step is another outstanding achievement in the digital audio technique:

These 4-bit words, which are all that remain of the 16 bits at the output, are corrected to such an extent that a signal-to-noise ratio of 75 dB is claimed by Intermetall over the audio frequency range.

applicator

R5620 . . . a programmable universal filter with switched capacitors

As their name implies, switched capacitor filters (SCFs) make use of switched capacitors as adjustable components, instead of variable resistors. This technique allows filter circuits to be completely integrated, with the filter parameters remaining extensively variable. The special feature is that SCFs require almost no external components. The centre frequency (f_0), for example has a fixed relationship with the clock frequency (f_t). Varying f_t results in an automatic variation of f_0. Particular, fixed frequency ratios between filters can therefore be achieved with ease and precision, by inserting flip-flops and similar digital circuits into the clock frequency line.

We shall not go into more theory at this stage; those readers interested in obtaining further details can consult the literature referred to in this article.

Programmable and universal

If the R 5620 were only an improved version of its predecessors, we would not have devoted an Applicator to it. However, this IC exhibits a number of characteristics which make it one of the more outstanding innovations. When comparing the device to the predecessor types from Reticon, one notices that the new IC has no fixed filter type, special application, filter Q or filter characteristic.

Even the versatile MF 10 from National Semiconductor cannot compete with features such as programmable Q and centre frequency, as well as the fact that no additional components are required for most applications. Its name is certainly justifiable: PUSCAF = Programmable Universal Switched Capacitor Active Filter.

Other attractions are: the low current consumption; it can be directly and digitally controlled (computers) and, last but not least, it is relatively inexpensive and is available to the hobbyist.

Internal circuits

As shown in figure 1, the IC has three inputs. LP is the input for the lowpass function, HP is that for the highpass function, and BP is used for the bandpass response. Two filters are integrated into the IC itself: a second-order (12 dB/octave) lowpass filter and a highpass filter. The third terminal (BP) is a combination of both filters; hence the bandpass response.

1

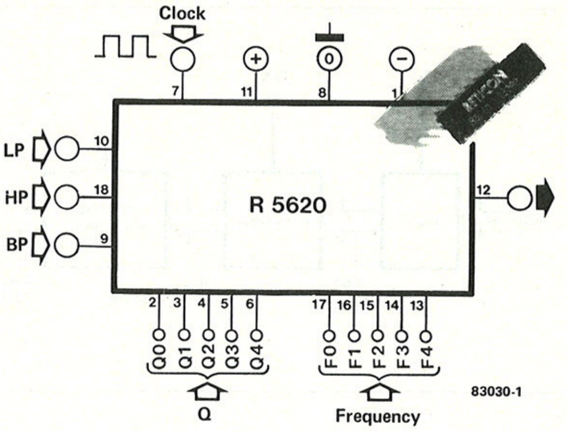


Table 1

Technical specifications

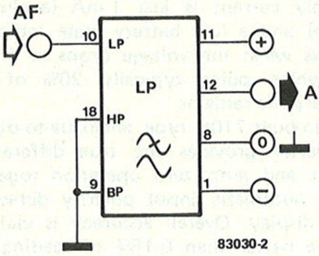
Supply voltage
minimum: ± 4 V
maximum: ± 11 V
Clock trigger voltage
minimum: 0.8 . . . 2 V
maximum: as per the supply voltage
Trigger pulse width
minimum: 200 ns
maximum: $1/f_t - 200$ ns
Clock frequency
minimum: 10 Hz
maximum: 1.25 MHz
Centre frequency
minimum: 0.05 Hz
maximum: 25 kHz
Supply current: 4.5 mA
Output voltage
maximum: ± 7 V
Output current
maximum: 4 mA
Noise (Q = 1)
typical: 270 µV
Dynamic range (Q = 1)
typical: 94 dB
Dynamic range (Q = 40)
typical: 84 dB
Insertion gain: 1
Capacitive output load
50 p max.
Dynamic output impedance
10 Ω
Input impedance
1 M/20 p
THD @ 1 kHz:
typical 0.2%

Table II RS5620 Q, F_0 Programming Table

Q	CODE $Q_4 \dots Q_0$	F_C/F_0	CODE $F_{04} \dots F_{00}$
.57	00000	200.0	00000
.65	00001	191.3	00001
.71	00010	182.9	00010
.79	00011	174.9	00011
.87	00100	167.2	00100
.95	00101	159.9	00101
1.05	00110	152.9	00110
1.2	00111	146.2	00111
1.35	01000	139.8	01000
1.65	01001	133.7	01001
1.95	01010	127.9	01010
2.2	01011	122.3	01011
2.5	01100	116.9	01100
3.0	01101	111.8	01101
3.5	01110	106.9	01110
4.25	01111	102.3	01111
5.0	10000	97.8	10000
5.8	10001	93.5	10001
7.2	10010	89.4	10010
8.7	10011	85.5	10011
10.0	10100	81.8	10100
11.5	10101	78.2	10101
13.0	10110	74.8	10110
15.0	10111	71.5	10111
17.5	11000	68.4	11000
19.0	11001	65.4	11001
23.0	11010	62.5	11010
* 28.0	11011	59.8	11011
* 35.0	11100	57.2	11100
* 40.0	11101	54.8	11101
* 80.0	11110	52.3	11110
* 150.0	11111	50.0	11111

* These values are maximum. Minimum values are greater than ⅔ Q. All other Q have a tolerance of ± 10% and typically are within a few percent.

2



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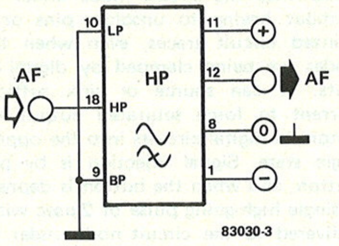

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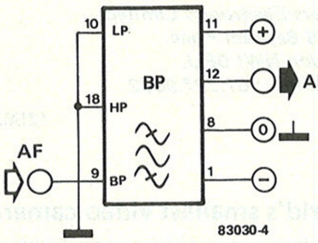

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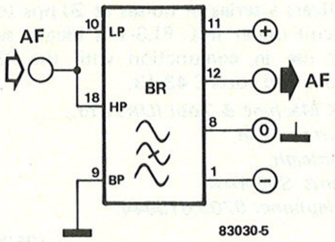

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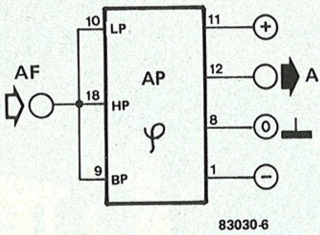

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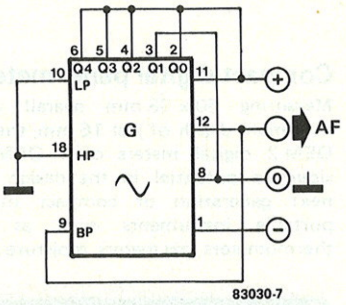

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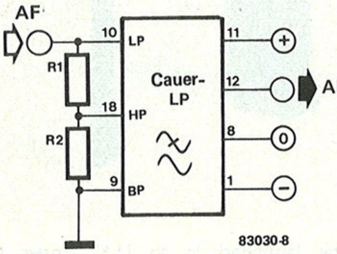

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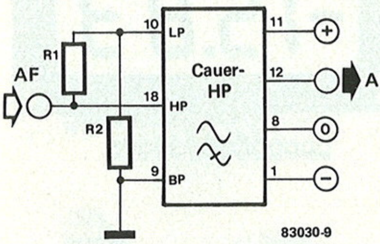


But these are by no means all the possibilities. Other types of filter can be "produced", depending on which inputs are driven by the AF signal and which are grounded. Thus it is possible to configure the device as a band-rejection (notch) filter (BR) and as an all-pass (AP) filter (phase shifter). With the BP input at the output one even obtains a (programmable) sinewave oscillator (G). Figure 2 to 7 show how the three inputs must be wired in order to obtain one of the six functions. When the device is configured according to figure 7 (sinewave oscillator) the Q is permanently set to 40. The transfer response of the filter can be varied by two additional resistors. Figures 8 and 9 show a Cauer lowpass and highpass filter respectively. Since Cauer filters are part of the group of 'music filters', this variant will be of interest in spite of the need for two external resistors. These resistors affect the centre frequency as well as the transfer response. The new centre frequency f_c of the Cauer filter is calculated with the following formulae:

$$\text{LP: } f_c = f_o\sqrt{\frac{R1 + R2}{R2}}$$

$$\text{HP: } f_c = f_o\sqrt{\frac{R2}{R1 + R2}}$$

Frequency f_o is the frequency which would be valid without resistors. Thus with one single IC it is possible to obtain eight different types of filter, merely by programming the device; 'programming' in this context means choosing the input configuration.

2-times 5 bits

So that a filter based on the R 5620 will have a defined centre frequency, a clock signal must be applied to it. Here we encounter another special feature of this IC: at a given clock frequency, f_o can be varied by applying 5-bit data.

The centre frequency of the sinewave generator, for example, can be shifted by two octaves simply by applying digital data: this is known as 'digital sweeping'. The resolution of this sweep is 32 (2^5) steps and logarithmic instead of linear. With a clock frequency of 1 MHz, therefore, a filter is obtained with an f_o of 5 kHz . . . 20 kHz; this is also precise because of the digital method without a preset potentiometer.

The same applies to the filter Q. This can also be set digitally in 32 logarithmic steps from 0.57 to 150. The tolerance of the set Q over the range 0.71 . . . 23 is less than 10%.

Table 2 shows which data must be applied to the Q and F inputs in order to obtain the desired Q and frequency. A '0' is a voltage of $<$ 0.8 V and a '1' is a voltage of $>$ 2 V. The Q and F inputs are both TTL and CMOS compatible, thus making the device ideally suited to microcomputer control. For fixed applications, however, DIL switches can be utilised or simple wire links.

Application

The device is suitable for almost any audio-frequency applications. It exhibits good dynamic response, noise and distortion performance (table 1).

One application could be as an active crossover network for loudspeakers, allowing precise matching to the room without soldering and modifications. Or as a digitally adjustable sinewave generator with constant output amplitude; or as an automatic notch filter to prevent feedback in PA systems; or . . .

Literature
Elektor 1/81: Switched capacitors
Elektor 9/82: MF 10
Reticon datasheet: R 5620

market

Kikusui DMM

Kikusui have introduced a 3½ digit mains powered digital multimeter to the British market. The Kikusui Model 1502 is for use in laboratory and production test and is available from the UK distributor, Telonic Berkeley. 1502 functions are AC and DC voltage, AC and DC current and resistance, and input circuits are protected against overvoltage and overcurrent. Maximum display value of 1999 is on LED's, with display of the selected function as well as automatic polarity indication.

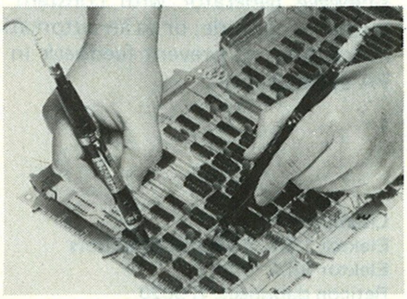
The 1502 has high sensitivity with 100 µV resolution on voltage ranges, 0.1 µA on current ranges, and 0.1 Ω on resistance ranges. An 'ΩLO' facility is included, providing for a less than 0.5 V maximum open terminal voltage when wanted. The double integration system is used and an automatic zero function dispenses with the need for zero adjustment. The instrument's basic accuracy is 0.1% and it is priced at £ 120 plus VAT.

Telonic Berkeley UK,
2 Castle Hill Terrace,
Maidenhead, Berkshire.
Telephone: 0628.73933.

(2513 M)

Logic probes and pulsers

OK's PRB-1 Digital Logic Probe detects pulses as short as 10 nsec, has a frequency response of better than 50 MHz and an automatic pulse stretching to 50 nsec but is competively priced at £ 33.24. It is compatible with RTL, DTL, HTL, TTL, MOS, CMOS and microprocessor logic families and also features 120 Kohm impedance, power lead reversal protection and over-voltage protection to 200 V (+V −V). Supply voltage range is 4-15 V but a PA-1 adaptor can be supplied for use with voltages from 15-25 V. The PLS-1 pocket-sized, multi-mode, high-current pulse generator will superimpose a dynamic pulse train (20 pps) or a single pulse onto the circuit mode under test, without having to unsolder pins or cut printed circuit traces, even when these nodes are being clamped by digital outputs. It can source or sink sufficient current to force saturated output transistors in digital circuits into the opposite logic state. Signal injection is by push-button, and when the button is depressed a single high-going pulse of 2 µsec wide is delivered to the circuit node under test. Pulse polarity is automatic, high nodes are pulsed low and low nodes are pulsed high, and holding the button down delivers a series of pulses at 20 pps to the circuit under test. PLS-1 is ideally suited for use in conjunction with the PRB-1 probe and costs £ 43.13.

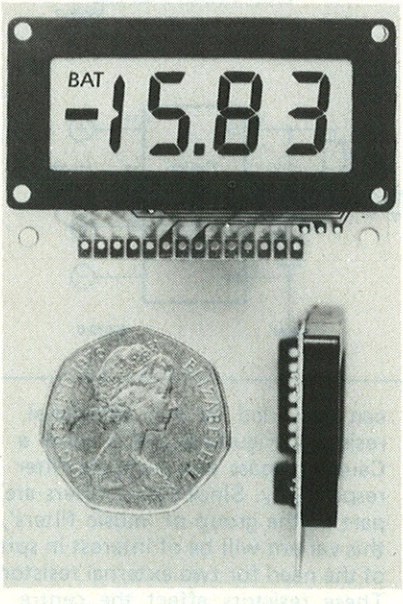


OK Machine & Tool (UK) Ltd.,
Dutton Lane,
Eastleigh,
Hants. S05 4AA.
Telephone: 0703.610944.

(2520 M)

Compact digital panel meter

Measuring 60 x 38 mm overall with a maximum depth of just 16 mm, these new OEM-2 digital meters offer OEMs considerable potential in the design of the next generation of compact handheld portable instruments such as digital thermometers, pH meters, moisture meters, pressure indications, resistance meters and multitesters.



Featuring a 3½ digit (± 1999) LCD display with large 0.5 in. (13 mm) high digits, these meters are easy to read in most ambient light conditions including direct sunlight. For applications requiring readings to be taken under all conditions, even dim lighting or in the dark, the OEM-2L version is available which incorporates a long life filament type lamp. Designed for a 9 V battery supply, the OEM-2 has a basic input sensitivity of ± 200 mV with a resolution of 100 µV. Supply current is just 1 mA (excluding lamp) and a low battery state indicator shows when the voltage drops to 7.2 V, at which point typically 20% of the battery life remains.

An in-built 7106 type analogue-to-digital converter provides the true differential input and auto zero operation together with automatic input polarity detection and display. Overall accuracy is claimed to be better than 0.15% of reading ± 1 count. Operating temperature range is 0 to +50° C with a typical coefficient of 80 ppm per ° C.

Anders Electronics Limited,
48-56 Bayham Place,
London NW1 0EU.
Telephone: 01.387.9092

(2563 M)

World's smallest video camera

A colour video camera, compatible with all video deck systems and weighing only 690 grams (including cable), is to be launched in to U.K. under the Konica brand by the Japanese company, Konishiroku. This revolutionary camera, the Konica Color VC, overturns conventional notions of the size and weight requirements for portable video cameras.

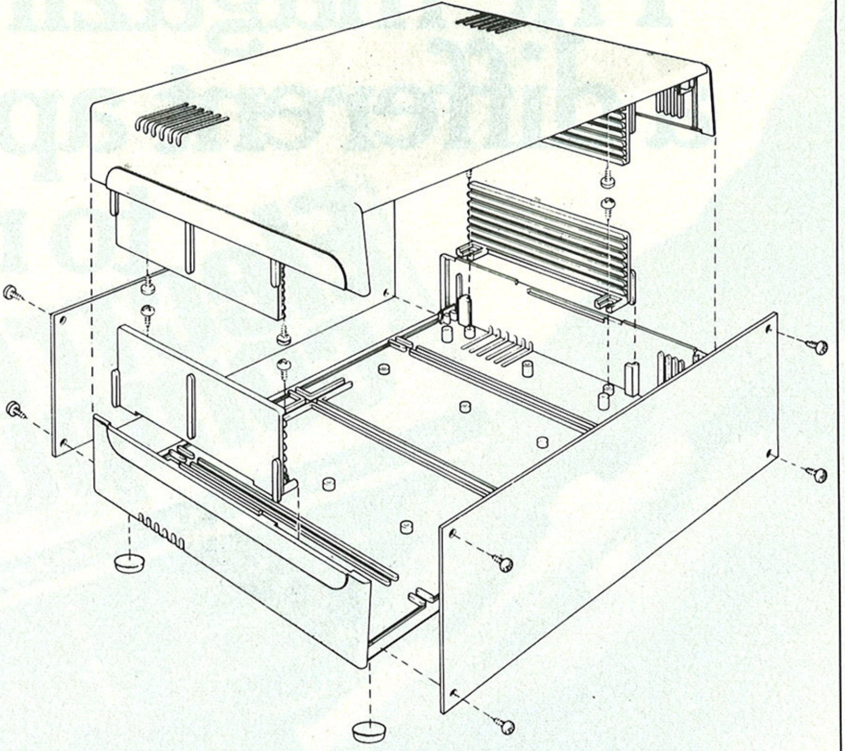
An important element in the camera is its energy saving design — power consumption being 10 to 20 per cent less than conventional portable video cameras. This is a decisive factor in extending total recording time. The camera, which has a 10-30 mm zoom lens and an optional electronic viewfinder, will be available with a black or silver body, and is to be launched in the U.K. in the Spring of 1983.

Alastair Sedgwick,
Carl Byoir & Associates Ltd.,
11a West Halkin Street,
London SW1X 8JL.
Telephone: 01.235.9292.

(2516 M)

New cabinet range

This Cabinet forms part of Amtron UK Ltd's range of 26 plastic and metal cabinets of varying dimensions. This particular model is constructed from shock-proof materials with front and rear panels of brushed aluminium, making it suitable for both industrial and laboratory electronics as well as for the home user. Built-in rails can be used to insert printed circuit boards vertically, horizontally or parallel to the front panel, but separate rails are also supplied for customer mounting. In addition, the kits for these cabinets contain vibration damping rubber feet and self tapping screws. The cabinet is available is three sizes:



OUTSIDE DIMENSIONS

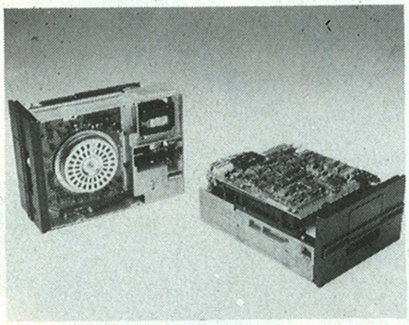
MODEL	WIDTH		HEIGHT		DEPTH	
	INCH	mm	INCH	mm	INCH	mm
00/3001.00	7,54	191,4	1,81	46	6,89	175
00/3001.02	7,54	191,4	2,36	60	6,89	175
00/3001.04	7,54	191,4	2,9	74	6,89	175

Amtron UK Ltd.,
7, Hughenden Road,
Hastings,
East Sussex.
Telephone: 0424.436004.

(2519 M)

5¼" disc drives

Rohan Computing is pleased to announce an addition to the Qume Track range of 5¼" drives: the model 592, which is a 96 track per inch, one megabyte capacity, double sided mini floppy drive.



The independently fluctured trigimbal head mechanism gives superior data reliability and significantly longer media life. The media life is further extended by the electronically dampened head load solenoid fitted to the drive, which far exceeds the recommendation for industry standard taptap tests. A band stepper head position mechanism gives 3 milliseconds track to track time, and a direct drive brushless DC motor dispenses with pulleys and belts offering a significantly longer drive motor life .
The main performance figures of the drives are 3 milliseconds track to track access time; 15 milliseconds settling time and 50 milliseconds head lower time with an average latency of a 100 milliseconds. Continuous power requirements are typically 10 watts or less offering very low heat dissipation. Additional features on the drive are an easy open and close bezel with an anticrunch door lock.

Rohan Computing Ltd.,
52 Coventry Street,
Southam,
Warwickshire CV33 0EP.
Telephone: Southam 092681.4045.

(2523 M)

Inexpensive 0-10 amp meter

An inexpensive 0-10 amps (close tolerance) moving coil meter for bench use has been introduced by Semiconductor Supplies for use where it can be used in preferance to more expensive equipment such as Avometers in experiments or on test rigs. Priced at £6.25 plus VAT with reductions for quantities, this equipment is ideal for use in schools.
The specification inlcudes mirror-scale and a sturdy plastics case on four rubber feet. Red and black terminal posts take banana plugs, spade terminals or bare wire ends. Heavy duty test leads are supplied. Size 110 x 110 x 90 mm (height, width, depth).

Semiconductor Supplies International Limited,
Dawson House,
128/130 Carshalton Road,
Sutton,
Surrey SM1 4RS
Telephone: 01.643.1126

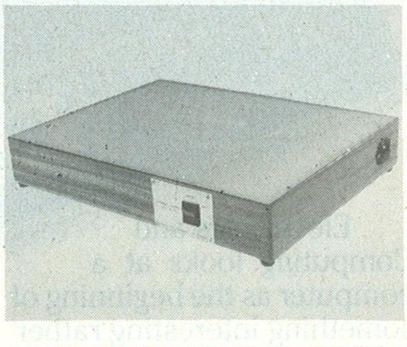
(2564 M)

PCB lightbox

Designed for the professional drawing office, the ECx2 Artwork Lightbox is correctly sized for the production of 2 : 1 PCB artwork to Eurocard dimensions 100 x 220 mm. The viewing panel is large enough to provide backlight for a full A3 size sheet of paper or draughting film and is made of 5 mm thick opal white Perspex fitted to give a flush top to the box with no sharp corners to cause operator discomfort.
Constructed in solid Mahogany, the smooth polished frame is mounted on a 9 mm plywood base and four heavy duty rubber feet to permit desktop use without risk of slipping or scratching. Illumination is provided by four fluorescent tubes which are controlled by dual chokes and starter circuits; overall power consumption is approximately 60 watts.

Electronic Assistance Limited,
Unit 1,
Brynberth Industrial Estate,
Rhayader,
Powys, LD6 5EN.
Telephone: 0597.810711

(2561 M)



The magazine with a different approach to micro's.

Electronics & Computing
MONTHLY
Britain's First Electronics & Computer Applications Magazine
SIDE TWO

Electronics and Computing looks at a computer as the beginning of something interesting rather than an end in itself.

We thought that using a micro to drive something other than a TV screen could open up fascinating possibilities.

A few simple circuits, used as building blocks, can stretch your computer, your imagination and your fun, a long way.

Combine a few switching circuits with some motor drive controls and a real time clock facility-driven by your micro, and you could build a robot to bring you tea in bed. Or the world's most impressive automated model railway.

That's what Electronics and Computing is all about – giving you ideas for new applications, and giving you the software to expand your micro.

Project by project we show you how to add another dimension to your computer.

Attached to the cover of the February issue are 10 free circuit cards to get you started.

And inside is enough information to build your own hi-res graphics computer.

All you need is a hot soldering iron and a cool 75p.

AT YOUR NEWSAGENTS FROM JAN 15TH.

WHERE ELECTRONICS AND COMPUTING INTERFACE.

elektor switchboard

WANTED: Elektor nos. 4 & 13, to buy or swap for Elektor nos. 1, 9, 17 or 19. Tel. 01 363 9166.

ELEKTERMINAL + ASCII Keyboard + Modulator, uncased. £50 o.n.o. Phone 061 748 0790, or write: Andy D'Rozarto, 8 Marlborough Road, Flixton, Manchester M31 3QG.

STEREO phones AKG-K 50 £2.00 Mr. A.C. Holdway, Flat 9, Back no. 10, Westwood Road, Portswood, Southampton, Hants.

BINATONE 5-Star 40-CH Mobile 27 MHz CB Transceiver, 4 watts, new, £ 45, very good value. Call 041 332 7695 after 7 p.m.

TELEQUIPMENT D/Beam Type D43 Scope wanted, circuit or w/shop manual plus any mods or handbook. Will pay any reasonable cost. J. Mitchell, 8 Rutland Street, Gorton, Manchester M18 8QH. Tel. 061 231 6522.

ELEKTOR Summer Circuits 1982 wanted £ 4.50. Tel. Treffgarne (043 787) 644 ask for Peter.

VOCODER for sale, built and calibrated to full Elektor spec, and in very smart case. Must be seen. £ 250 o.n.o. Mr. M.N.A. Lee, Mid-Bay, Seasalter Beach, Whitstable, Kent CT5 4EV. Phone evenings 0227 264115

INTELEKT Chess Computer, cased, working, £ 35. Elekterminal + PSU + page. Ext. & Keybaord. £ 30. Comp. PSU 5 V15 A ±12 V, 1,5 A, 24 V 2 A. £ 40. Mr. D.D. Wells, 67 Bradvue Crescent, Bradvile, Milton Keynes MK13 7AH. Tel. 0908 319765.

Programmable scanner required. Phone 0323-57769. Colin evenings only (Eastbourn).

BASIC MICRO 4k RAM, Elekterminal with ASCII keyboard, with PSU and modulator. All in working order £ 175 o.n.o. will split.
Mr. N.C. Waller,
30 Woodlands Court.
Dunbartonshire G83 0SN.

WANTED: Back issues 1979 - nos. 47 March and 51/52 July/August. 1980 - no. 57 January. Tel. day-453440033 L39 (local) evening-453460044 (Denmark)

REALISTIC MPA 35 35 watt PA amplifier, 2 microphones, phono aux. priority switch, hardly used. £ 30. Tel. 061 9697716

TELETYPE recent ASR 33. Keyboard printer tape punch/reader. Acoustic case RS32 2 line overhaulded. £ 75 + carriage. Tel. Leeds 673951

ELEKTORS - nos. 1 to 92 inclusive, only no. 81 missing. Offers please. Mr. P.J. Sankey, 24 Pains Way, Amesbury, Salisbury, Wilts. SP4 7RS.

FURZEHILL Oscilloscoop good/working. For sale or swap for student's stock, iron, Verobloc, components, etc. Offers? Write: Shaheen Aslam, 9 Southfield Road, Middlesbrough, Cleveland TS1 4BX.

TRANSCENDANT 2000 Synthesizer built, perfect - £ 150, minisonic Mk2 ditto, Offers? 2 DFMS £ 15 each, 10 boxes incomplete kits. Hugh Bridge, 363 Kennington Lane, Vauxhall, London SE11 5QY. (01 735 1862)

ZX SPECTRUM full working order £ 75 + £ 2 post. 2 Sharp Stereo Cassettes £ 45 o.n.o. S.A.E. please. No callers. CB wanted. Mr. D. Martin, 29 St. Johns Close, Leatherhead, Surrey.

COMPUTER, home built, MC6800 & Terminal £ 35. PSU 10 A, ± 12 V 1 A £ 25. Cassette Interface £ 15. Paper Tape Reader £ 20. Mr. D.D. Wells, 67 Bradvue Crescent, Bradville, Milton Keynes MK13 7AH. Tel. 0908 319765.

WANTED: SE3A Scope Tube and Telequipment S32 Circuit Diagram. J. Glover, 1 Broyony Cottages, Hambledon, Godalming, Surrey GU8 4HJ.

CREED 75 Teletype with Tape Reader/Punch and separate Reader Unit, all cables, £ 75 o.n.o. Tel. (0977) 45570 (near Barnsley).

HEATHKIT Scope Single Beam Model 10-103, Mint condition, £ 45, Manual included. Tel. 01 747 1635

VIDEO GENIE EG3003 Computer, 2 Manuals, Monitor, Integral Cassette Recorder, 2 games £ 230. Phone Crayford 528119.

ROBERTS RADIO RM50 in new condition. Also DA116 DMM. Write with offers. Spare electronics magazines required. B.K. Jain, 17 Taylors Lane, London NW10.

TRIO TR8400 70cm. FM Transceiver £ 250. Yaesu FT290, Nicads and case, £ 220. Both o.n.o., both original packing. D.D. Hobbs, 46 Gloucester Road, Bridgewater, Somerset TA6 6DZ.

FREE advertising for our readers!

Rules:

- Private advertisers only. No trade, no business.
- Full address or private telephone number; no post office boxes.
- Items related to electronics only. Software only when related to Elektor computer systems.
- Maximum length: 114 characters — letter, numeral, comma, space. etc. (not including address and/or telephone number).
- One advertisement per reader per month. To enforce this rule, a switchboard voucher will be printed each month.
- Elektor cannot accept responsibility for any correspondence or transaction as a result of a 'switchboard' ad, nor as a result of any inaccuracy in the text.
- Ads will be placed in the order in which they are received.
- We reserve the right to refuse advertisements, without returning them.

I am a private reader. I have read your rules and I enclose a valid switchboard voucher. Please place the following advertisement, free, in the next available space.

BLOCK CAPITALS PLEASE — ONE CHARACTER TO EACH BOX

Name and address:

Send to:
Elektor switchboard,
Elektor House
10 Longport
Canterbury CT1 1PE

All advertisements *must* include the voucher printed here. They must be post-marked within the month indicated.

elektor switchboard FEBRUARY '83

CRICKLEWOOD ELECTRONICS LTD

40 CRICKLEWOOD BROADWAY, LONDON NW2 3ET. Tel: 01-4520161 TELEX: 914977 CRIKEL G

SUPERIOR QUALITY CARBON FILM RESISTORS' HISTAB LOW NOISE

¼ W 10 Ω - 1MΩ 5% E24	2p
½ W 10Ω - 10MΩ 5% E24	3p
1 W 10Ω - 10MΩ 5% E12	6p
2 W 10Ω - 10MΩ 5% E12	15p

METAL OXIDE/FILM RESISTORS

Very high thermal & electrical stability. Extremelu low noise

0.4 W 10Ω - 1MΩ 2% E24	5p
0.1 W 10Ω - 1MΩ 1% E24	8p

LOW OHMIC VALUE RESISTORS (½ W OR ¼ W)

0.22Ω - 8.2Ω E12	11p

WIREWOUND RESISTORS 5%

2.3 W 0.22Ω - 330Ω E12	28p
4.7 W 0.47Ω - 6K8 E12	33p
10 - 11 W 1.0Ω - 33K E12	37p

LOW NOISE ROTARY POTS
E3 Series

4.7K - 2M Lin	32p
4.7K - 2M Log	32p
As above with DP switch	80p
As above but stereo (no switch)	90p

MICRO-MINI 100V CERAMIC PLATE CAPS
5% or better
E12 Series

1pF - 10nF	7p

DISCOUNTS ON QUANTITY PLEASE PHONE

SIEMENS 63V MINI MONOLYTHIC CERAMIC

10nF	10p
22nF	10p
33nF	10p
47nF	10p
68nF	10p
100nF	14p

SIEMENS POLY-C 5% 7.5mm 250V CAPACITORS
E12

1nF - 68nF	10p
82nF - 150nF	15p

5% 7.5mm 100V CAPACITORS
E12

100nF-180nF	12p
220nF-270nF	15p
330nF-390nF	20p
470nF-560nF	27p
680nF	32p
1µF (10mm)	35p

Complete range of other voltages & spacings in stock.
Please phone

ICE MULTI-METERS

Microtest 80	£ 16.00
Supertest 680R	£ 32.00

TANTALUM BEADS

1/35 V	14p
22/35 V	14p
33/35 V	14p
47/35 V	14p
68/35 V	14p
1.0/35 V	14p
2.2/16 V	14p
2.2/35 V	22p
3.3/35 V	22p
4.7/16 V	22p
4.7/35 V	24p
6.8/25 V	26p
6.8/35 V	25p
10/16 V	25p
10/35 V	34p
15/10 V	22p
15/25 V	32p
22/6.3 V	26p
22/16 V	32p
33/10 V	38p
47/6.3 V	43p
100/3 V	37p

Feedthrough Capacitor

1000pF 500V	7p

MINI FILM MULLARD TRIMMERS

1.4 - 5pF (800MHz)	23p
2 - 10 pF (600MHz)	27p
2 - 22pF (400MHz	29p
5.5 - 65pF (200MHz)	36p

630VDC 250VAC POLYESTER CAPS

10nF	12p
15nF	18p
22nF	18p
47nF	32p
100nF	35p
150nF	37p
220nF	40p

Fully enclosed Piher Pre-sets
E 3 Series
100Ω 10M

Cermet 20 Turn Precision Preset
50Ω, 100Ω, 200Ω, 500Ω
1K, 2K, 5K, 10K, 20K, 50K, 100K, 250K, 500K
99p eac'

Mini Vert	14p
Mini Horiz	14p
Standard Vert	17p
Standard Horiz	17p
Thumbwheel or ¼" Spindle for Standard Pre sets only	8p

160V Polystyrene Caps 5% or better
10pF, 15pF, 22pF, 27pF, 33pF, 39pF, 47pF, 68pF, 100pF, 150pF, 180pF, 220pF, 270pF, 330pF, 390pF, 470pF, 680pF, 820pF, 1nF, 1.5nF, 2.2nF, 3.3nF, 4.7nF, 10nF
12p each

C280 or Equiv Polyester Caps Radial Long Leads

10nF, 15nF, 22nF, 33nF, 47nF, 68nF, 100nF	9p
150nF, 220nF	11p
330nF, 470nF	16p
680nF, 1µF	24p
1.5µF, 2.2µF	44p

Veroboard 0.1" Copper Clad

2.5 × 3.75	72p
2.5 × 5	80p
3.75 × 3.75	80p
3.75 × 5	93p
2.5 × 17	2.50
3.75 × 17	3.30
4.79 × 17	4.20
VQ Board	1.50
Dip Board	3.25
Track Cutter	1.15
Pin Insertor	1.59
100 Pins	.50
Verobloc	3.70

Vero Wiring

Pen + Spool	3.00
Spare Spool	72p
Combs	6p

Ferric Chloride
60% Solution

250ml bottle	£1.60

Cermet 20 Turn Precision Presets
50Ω, 100Ω, 200Ω, 500Ω, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 250K, 500K
95p each

1000vdc Caps (300VAC) Axial

1nF, 2.2nF	23p
4.7nF, 6.8nF	26p
10nF	28p
22nF, 33nF	37p
47nF	45p
100nF	48p
220nF	74p
470nF	1.10

1500VDC Caps (300VAC) Axial

1nF, 2.2nF	30p
3.3nF, 4.7nF	32p

2000VDC Axial

100nF 20%	76p

Ceramic Hi Volt Disc Capacitors

100p/1KV	20p
100p/2KV	24p
100p/3KV	26p
100p/4KV	28p
220p/6KV	30p
470p/2KV	27p
470p/6KV	32p
1n/2KV	28p
1n/6KV	32p
2n2/2KV	30p
2n2/4KV	32p
2n2/5KV	33p
3n3/2KV	31p
3n3/4KV	32p
4n7/4KV	33p

400V Polyester Capacitors

1nF, 1.5nF, 2.2nF	18p
3.3nF, 4.7nF, 6.8nF	19p
10nF, 15nF, 22nF	20p
33nF, 47nF, 68nF	22p
100nF, 150nF	25p
220nF	38p
330nF	58p
470nF	66p

ETCH RESIST TRANSFERS

1. Thin lines
2. Thick lines
3. Thin bends
4. Thick bends
5. DIL pads
6. Transistor pads
7. Dots + holes
8. 0.1" edge cons.
9. Mixture

any sheet of above 30 p
Set of 13 sheets 3.00

Wire & Cable
Prices per metre
Solid Hook-up Wire

Any colour	5p

Quality Electrolytics
By Matsushita or Siemens
(other good makes may be sent only in the rare event of supply difficulty)

AXIALS

uFd	V	
.47	63	8p
.47	100	9p
.47	350	30p
1	63	8p
1	100	9p
1	500	40p
2.2	25	8p
2.2	63	9p
2.2	100	11p
2.2	350	30p
3.3	25	10p
3.3	40	11p
3.3	63	12p
4.7	16	8p
4.7	25	9p
4.7	40	11p
4.7	63	12p
4.7	100	14p
10	25	8p
10	40	12p
10	63	14p
10	100	16p
10	350	55p
22	25	11p
22	40	14p
22	63	16p
22	100	21p
47	25	14p
47	40	17p
47	63	26p
47	100	28p
100	16	14p
100	25	16p
100	40	22p
100	63	25p
100	100	30p
220	10	16p
220	16	17p
220	25	22p
220	40	25p
220	63	30p
220	100	40p
330	16	19p
330	25	22p
330	63	38p
470	16	22p
470	25	28p
470	40	33p
470	63	43p
470	100	60p
1000	16	30p
1000	25	38p
1000	40	46p
1000	63	65p
2200	16	40p
2200	25	63p
2200	40	70p
2200	63	134p
4700	16	75p
4700	35	120p

Beautiful Mini Radial Low Voltage
Matsushita only

uFd	V	
10	16	6p
22	10	6p
22	16	7p
47	10	7p
47	16	8p
100	10	9p
100	16	10p
220	10	11p
220	16	12p
470	10	17p
470	16	18p
1000	10	20p
1000	16	24p
2200	10	34p
2200	16	44p

Mains/Speaker Cable (per metre)

Twin 1 amp	14p
Twin 2½ amp	16p
3 Core 2½ amp	18p
3 Core 6 amp	31p
3 Core 13 amp	56p

Solid Multicore

4 Core	33p
8 Core	39p
12 Core	46p
50 Core	1.37

Screened Cable

Single	14p
Stereo	27p
Mini Single	12p
Mini Stereo	15p
4 Core 4 Screens	44p
4 Core 1 Screen	54p
8 Core	61p
12 Core	80p

Aerial Cable

50Ω RG58A	36p
75Ω UHF	36p
75Ω VHF	28p
300Ω Flat	14p

Rainbow Ribbon Cable

10 Way	65p
24 Way	152p
40 Way	210p

PHOTO SENSITIVE PCB
1st Class Epoxy Glass. For better results than spraying. Expose to UV

Single sided	
100 x 160	1.55
100 x 220	1.90
203 x 114	1.85
233 x 220	3.99
Double sided	
100 x 160	1.65
100 x 220	2.15
203 x 114	2.21
233 x 220	4.55
Developer for above (do not use Sodium Hydroxide) 500 ml	2.50

DALO ETCH RESIST PEN

+ spare nib	90p

ANTEX SOLDERING IRONS

C240 (15W)	4.59
X25 (25W)	4.99
Iron stand	1.65
C240 Element	1.99
X25 Element	2.05
Bits C240	
No 2 (Small)	65p
No 3 (Med)	65p
No 6 (Micro)	65p
Bits X25	
No 50 (Small)	65p
No 51 (Med)	65p
No 52 (Lge)	65p

SOLDER
125gms

18 swg	2.95
22 swg	3.10

DIL SOCKETS

Pins	Lo-prof	W.Wp.
8	8 p	25 p
14	9 p	35 p
16	10 p	40 p
18	16 p	50 p
20	20 p	–
22	22 p	–
24	24 p	70 p
28	28 p	79 p
40	30 p	99 p

TRANSISTORS
Probably the largest retail variety in UK
If you don't see what you want please phone or write as this is not a full list

2N404	1.50
2N914	20p
2N916	39p
2N917	65p
2N918	33p
2N929	36p
2N929A	45p
2N930	20p
2N930A	30p
2N1131	24p
2N1132	25p
2N1302	45p
2N1303	65p
2N1304	60p
2N1306	65p
2N1308	65p
2N3170	58p
2N1420	66p
2N1483	2.95
2N1485	3.47
2N1507	42p
2N1524	58p
2N1702	3.20
2N1711	35p
2N1889	50p
2N1890	50p
2N1893	30p
2N1974	1.50
2N2060	7.14
2N2102	39p
2N2217	39p
2N2218	33p
2N2218A	25p
2N2219	27p
2N2219A	28p
2N2220	22p
2N2221	22p
2N2221A	23p
2N2222	24p
2N2222A	25p
2N2223	2.60
2N2223A	4.15
2N2303	39p
2N2368	25p
2N2369	19p
2N2369	18p
2N2405	88p
2N2410	1.15
2N2411	3.60
2N2412	80p
2N2477	95p
2N2483	25p
2N2484	26p
2N2491	8.00
2N2646	45p
2N2647	98p
2N2714	12p
2N2848	60p
2N2875	2.20
2N2890	1.10
2N2891	2.28
2N2892	3.00
2N2904A	27p
2N2905	28p
2N2905A	29p
2N2906	25p
2N2906A	30p
2N2907	25p
2N2907A	26p
2N2920	3.47
2N2923	25p
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2N3391	30p
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2N3395	26p
2N3396	26p
2N3397	27p
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2N3405	50p
2N3416	24p
2N3417	23p
2N3420	2.50
2N3439	98p
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2N3445	4.80
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2N3448	6.56
2N3468	1.00
2N3512	1.06
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2N3563	20p
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2N3567	55p
2N3568	50p
2N3569	50p
2N3570	2.54
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2N3572	2.06
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2N3607	28p
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2N4915	2.95
2N4916	48p
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2N5194	79p
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2N5298	1.37
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2N5306	37p
2N5307	40p
2N5308	25p
2N5354	19p
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2N5447	16p
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2N5459	29p
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2N6131	98p
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40410	1.80
40411	2.85
40412	90p
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40537	96p
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40601	2.36
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40603	1.09
40604	1.85
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40622	1.45
40625	1.60
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40637	2.00
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40822	1.80
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AD136	6.75
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BD187	1.09
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BD245A	1.14
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BD246A	1.20
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BD250A	2.11
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BD433	79p
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BD540	85p
BD540C	1.20
BD675	72p
BD676	77p
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BD678	83p
BD711	1.32
BD712	1.32
BDX14	1.30
BDX18	1.59
BDX32	3.47
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BDY23	3.40
BDY25	3.75
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BDY56	1.80
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BDY58	6.15
BDY60	1.60
BDY61	2.80
BDY62	2.34
BDY92	3.75
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BF224J	32p
BF225J	35p
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BF244A	35p
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BF245A	
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BF246	52p
BF246A	
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BF247A	54p
BF247B	55p
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BF255	42p
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BFX85	28p
BFX86	28p
BFX87	25p
BFX88	26p
BFX89	1.75
BFY18	48p
BFY19	1.10
BFY37	1.20
BFY39	50p
BFY41	1.16
BFY50	23p
BFY51	23p
BFY52	23p
BFY53	31p
BFY56	31p
BFY56A	68p
BFY75	75p
BFY76	50p
BFY77	80p
BFY78	80p
BFY90	79p
BSV81	1.87
BSW41	95p
BSW67	1.00
BSW70	1.00
BSX19	24p
BSX20	24p
BSX21	40p
BSX27	78p
BSX28	66p
BSX29	34p
BSX39	80p
BSX60	75p
BSX61	80p
BSX76	50p
BSX77	55p
BSY24	77p
BSY25	1.00
BSY26	35p
BSY29	70p
BSY39	47p
BSY54	40p
BSY65	58p
BSY95A	25p
BU104	2.22
BU105	1.70
BU109	3.29
BU126	1.47
BU204	2.25
BU205	1.75
BU206	1.89
BU208	1.98
BU326S	2.35
BU406	1.45
BU407	1.45
BU408	1.35
BU409	1.25
BU500	2.95
BUV20	11.00
BUV21	10.90
BUV23	13.60
BUV24	12.10
BUV25	15.00
BUX20	17.00
BUY18S	3.95
E430	5.60
J300	48p
J310	53p
MA8001	45p
MA8002	62p
MA8003	39p
MD7000	2.60
ME0401	25p
ME0402	30p
ME0404	25p
ME0411	35p
ME0412	35p
ME0413	35p
ME0414	48p
ME0461	45p
ME0462	45p
ME1001	45p
ME1002	45p
ME1075	45p
ME1100	45p
ME1120	48p
ME3002	25p
ME4001	45p
ME4002	45p
ME4003	45p
ME4101	25p
ME4101	25p
ME4103	25p
ME4104	25p
ME6001	25p
ME6002	25p
ME6003	25p
ME6101	29p
ME6102	28p
ME8001	47p
ME8002	62p
ME8003	50p
ME9001	56p
ME9002	56p
MFE3004	2.36
MJ400	2.98
MJ420	2.26
MJ430	2.98
MJ440	
MJ481	1.69
MJ491	1.72
MJ802	3.99
MJ900	2.90
MJ901	3.10
MJ1000	2.50
MJ1001	3.00
MJ1800	3.60
MJ2500	2.19
MJ2501	2.25
MJ2955	1.00
MJ3000	2.19
MJ3001	2.25
MJ3701	2.55
MJ4502	3.99
MJE340	53p
MJE370	97p
MJE371	99p
MJE520	92p
MJE521	94p
MJE1090	3.65
MJE1100	3.65
MJE2901	3.65
MJE2955	99p
MJE3055	69p
MP8111	1.00
MP8112	1.39
MP8121	1.35
MP8122	1.40
MP8123	1.16
MP8512	1.59
MPF102	39p
MPF103	29p
MPF104	29p
MPF105	29p
MPF112	59p
MPF121	1.69
MPS3638	27p
MPS3640	40p
MPS4356	60p
MPS6517	47p
MPS6518	47p
MPS6530	37p
MPS6560	32p
MPS6562	32p
MPSA05	23p
MPSA06	25p
MPSA10	28p
MPSA12	29p
MPSA13	48p
MPSA14	46p
MPSA16	30p
MPSA18	65p
MPSA20	48p
MPSA42	49p
MPSA43	49p
MPSA55	28p
MPSA56	30p
MPSA65	40p
MPSA66	47p
MPSA70	45p
MPSA92	39p
MPSA93	39p
MPSL01	42p
MPSL51	48p
MPSU01	84p
MPSU04	1.32
MPSU05	55p
MPSU06	56p
MPSU07	75p
MPSU51	88p
MPSU55	58p
MPSU56	59p
MPSU57	1.20
MRF421	poa
MRF453	poa
MRF454	poa
MRF475	7.55
MRF477	poa
MRF479	poa
MRF604	poa
NKT124	63p
NKT125	49p
NKT126	47p
NKT128	42p
NKT129	40p
NKT135	40p
NKT137	42p
NKT210	42p
NKT215	40p
NKT216	65p
NKT218	44p
NKT219	40p
NKT224	40p
NKT225	40p
NKT229	40p
NKT238	46p
NKT239	44p
NKT240	42p
NKT241	40p
NKT242	40p
NKT243	86p
NKT243	86p
NKT244	40p
NKT254	40p
NKT261	40p
NKT262	40p
NKT271	40p
NKT272	40p
NKT275	40p
NKT281	47p
NKT404	2.68
NKT405	2.80
NKT406	2.50
NKT453	2.40
NKT603F	56p
NKT613F	55p
NKT674F	55p
NKT677F	55p
NKT713	47p
NKT717	52p
NKT734	55p
NKT736	58p
NKT773	40p
NKT781	43p
NKT12329	50p
NKT12429	57p
NKT13329	50p
NKT13429	54p
NKT16229	59p
NKT20329	38p
OC20	2.30
OC22	2.00
OC23	2.00
OC25	2.50
OC28	1.70
OC29	2.35
OC35	2.35
OC41	80p
OC43	70p
OC44	82p
OC70	50p
OC71	50p
OC72	50p
OC82	50p
OC82D	70p
OC83	75p
P346A	58p
R2008B	2.14
R2010B	1.88
SC107	27p
SC108	27p
SC109	27p
TIP29A	32p
TIP29C	38p
TIP30A	35p
TIP30C	38p
TIP31A	38p
TIP31C	39p
TIP32A	38p
TIP32C	42p
TIP33A	65p
TIP33C	78p
TIP34A	74p
TIP34C	88p
TIP35A	1.09
TIP35C	1.28
TIP36A	1.29
TIP36C	1.39
TIP41A	49p
TIP41C	55p
TIP42A	55p
TIP42C	65p
TIP49	1.20
TIP50	1.40
TIP53	1.57
TIP54	1.59
TIP110	74p
TIP112	90p
TIP115	81p
TIP117	96p
TIP120	69p
TIP122	73p
TIP125	1.20
TIP127	1.27
TIP130	1.50
TIP132	1.60
TIP135	1.60
TIP137	1.80
TIP140	1.04
TIP142	1.04
TIP145	1.19
TIP147	1.19
TIP162	4.95
TIP2955	77p
TIP3055	70p
TIS37	62p
TIS43	40p
TIS45	66p
TIS46	66p
TIS47	49p
TIS48	65p
TIS49	66p
TIS50	60p
TIS51	65p
TIS52	70p
TIS53	97p
TIS54	85p
TIS55	66p
TIS58	92p

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Items not fully covered on this list include: **OPTO:** 7 seg LEDs, LCDs, bezelled LEDs, Lamps, Lampholders. **FUSES:** 20 mm, 1¼ inch, slow or quick blow, Fuseholders. **CONNECTORS:** DIL, DIN, Phono, 1 mm, 2 mm, 4 mm, Bulgin, USA, I.E.C. **KNOBS:** Plastic, Aluminium, Anodised, Collet, Pointer. **SWITCHES:** Toggle, Biased, Rocker, Rotary, Slide, DIL, Push. **METERS:** LCD, Analogue, Test and Panel. **TOOLS:** Pliers, Cutters, Strippers, Trimmers, Cable Cutters. And much, much more . . . . All in stock items (that's 95%) posted same day. OFFICIAL ORDERS FROM SCHOOLS, GOVT. DEPTS ETC. WELCOME. OVERSEAS ORDERS WELCOME (CWO + ADEQUATE POSTAGE) QUANTITY DISCOUNTS BY NEGOTIATION.

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TIS60	42p
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TIS91	30p
TIS92	30p
TIS93	54p
VN10KM	60p
VN46AF	84p
VN66AF	85p
ZTX107	10p
ZTX108	10p
ZTX109	10p
ZTX300	13p
ZTX301	15p
ZTX302	15p
ZTX303	23p
ZTX304	15p
ZTX310	35p
ZTX311	32p
ZTX312	35p
ZTX313	36p
ZTX314	24p
ZTX320	35p
ZTX330	35p
ZTX341	28p
ZTX500	14p
ZTX501	14p
ZTX502	14p
ZTX503	17p
ZTX504	24p
ZTX510	34p
ZTX530	24p
ZTX531	25p
ZTX650	45p

DIACS

BR100	40p
ST2	25p

THYRISTORS
Sensitive Gate
Small Signal

2N5060	30p
2N5061	32p
2N5062	35p
2N5063	37p
2N5064	40p
BR101	75p
BRY39	60p
BRY55-100	60p
BRY55-300	67p
BRY56	50p
TIC44	35p
TIC47	50p

4, 8 & 12 Amps
Texas TO220
Suffix: A = 100V
B = 200V
C = 300V
D = 400V
M = 600V

	TIC106A	46p
	TIC106B	47p
	TIC106C	48p
4A	TIC106D	59p
	TIC106M	68p
	TIC116A	66p
	TIC116B	68p
8A	TIC116C	71p
	TIC116D	73p
	TIC116M	80p
	TIC126A	72p
12A	TIC126B	72p
	TIC126C	73p
	TIC126D	77p
	TIC126M	95p

SIEMENS THYRISTORS

1.2 amp plastic	
Bst B0106 (100V)	60p
Bst B0113 (200V)	70p
Bst B0146 (700V)	1.12
4.7 amp plastic	
Bst B0206 (100V)	80p
Bst B0213 (200V)	1.10
Bst B0246 (700V)	2.00

TV Thyristors

2N4444	1.80
BT101-500R	1.40
BT106	1.50
BT116 Use TIC116M	
BT119	1.70
BT120	1.50
BT121	1.30
BT139/600	2.50

TRIACS
Texas 400V
TO220 Case

TIC206D(4A)	66p
TIC225D(6A)	74p
TIC226D(8A)	88p
TIC236D(12A)	1.16
TIC246D(16A)	1.22
TIC253D(20A)	1.90
TIC263D(25A)	2.11

Other Triacs

2N5756 (TO5)	1.44
2N6155 (TO127)	3.39
40432 (Quadrac)	2.23
40486 (TO5)	1.65
40512	2.70
40576 (TO66)	3.33
40842	1.92

DIODES

1N34A	30p
1N821	70p
1N823	92p
1N914	4p
1N916	6p
1N1190	1.47
1N1192	1.75
1N1194	1.65
1N1194A	1.80
1N1196A	2.41
1N1198A	2.65
1N1201A	97p
1N1204A	1.00
1N1206	1.20
1N3063	36p
1N3065	48p
1N3492	1.85

1N3493	2.20
1N3493R	2.20
1N3602	36p
1N3604	45p
1N3766	3.00
1N3768	4.50
1N3768R	4.50
1N4001	4p
1N4002	4½p
1N4003	5p
1N4004	5½p
1N4005	6p
1N4006	6½p
1N4007	7p
1N4009	20p
1N4148	6p
1N4150	18p
1N4448	22p
1N4517	22p
1N5172	30p
1N5176	94p
1N5400	12p
1N5401	13p
1N5492	14p
1N5403	15p
1N5404	16p
1N5405	17p
1N5406	18p
1N5407	19p
1N5408	20p
1N5024	52p
1N5625	60p
1N5626	62p
1N5627	68p
1S44	10p
1S131	40p
1S134	56p
1S421	1.00
1S421R	1.00
1S940	10p
1S941	11p
1S961	22p
AA119	28p
AA129	57p
AA144	25p
AAY30	44p
AAY33	46p
AAZ17	27p
BA100	22p
BA102	25p
BA115	25p
BA133	40p
BA138	30p
BA142	20p
BA144	15p
BA155	15p
BA156	38p
BA182	40p
BA201	18p
BA202	26p
BA316	25p
BA317	25p
BA318	30p
BAV10	16p
BAV19	15p
BAV20	15p
BAV49	15p
BAX13	10p
BAX16	11p
BAY38	20p
BAY44	15p
BAY93	10p
BB103B	70p
BB103G	70p
BB104B	80p
BB104G	80p
BB105	52p
BB105A	57p
BB105B	58p
BB109G	65p
BY126	20p
BY127	22p
BY134	52p
BY182	1.26
BY188A	65p
BY206	36p
BY207	36p
BY223	1.56
BY297	48p
BY299	55p
BYW11-800	1.40
BYW11-1000	2.00
BYW12-100	1.30
BYW12-200	1.40
BYW12-400	2.00
BYX10	36p
BYX50-200R	2.00
BYX55-350	62p
BYX71-350	1.10
BYX71-600	1.52
ITT33	15p
ITT44	10p
ITT921	10p
ITT923	15p
ITT2002	27p
MZ2361	1.80
OA10	70p
OA47	20p
OA90	10p
OA91	10p
OA95	20p
OA200	20p
OA202	20p
RAS508AF	75p
SPD9000	75p
SPD9002	95p

2 amp type Square with hole	
S01 (100)	37p
S02 (200)	40p
S04 (400)	40p
S08 (800)	55p

BRIDGE RECTIFIERS
(PIV shown in brackets)

1 amp type	
W01 (100)	20p
W02 (200)	26p
W04 (400)	28p
W08 (800)	40p
6 amp type Square with hole	
PW01 (100)	50p
PW02 (200)	78p
PW04 (400)	85p
PW06 (600)	90p
25 amp type Metal clad with hole	
K01 (100)	2.20
K02 (200)	2.30
K04 (400)	2.80
K06 (600)	3.40
Proprietory Bridges	
B40C1500	1.20
B80C3700	1.80
BY164	55p
BY179	92p

ZENER DIODES

400-500 mW E24 Series 2.4-47 V	8p
1.3 Watt E24 Series 3.3-82 V	15p
2.5 Watt E24 Series 7.5-75V	1.10
5W wire ended following voltages only 3V3, 3V6, 4V3, 4V7, 5V6, 7V5, 8V2, 8V7, 9V1, 10V, 12V, 20V, 33V, 51V, 62V, 68V	1.25
10W Pos. Stud Following voltages only 7V5, 13, 18, 20, 24, 27, 30, 33, 68, 82, 91, 100, 110	1.25
20W Pos. Stud (BZY93 series) E24 values 7V5-75V	2.00

OPTO ELECTRONICS

2N5777	78p
2N5778	88p
2N5779	1.09
4N25	1.10
BP100	1.40
BP104	1.00
BPX25	2.47
BPX29	2.47
BPX48	6.76
BPX60	4.75
BPX61	3.48
BPX63	2.93
BPX79	4.60
BPX86	4.15
CQX13	40p
CQX23	53p
CQX33	48p
LD30A	15p
LD36A	18p
LD37A	18p
LD52A	12p
LD56A	15p
LD57A	15p
LD52C	30p
LD56C	30p
LD57C	30p
LD80A	18p
LD86A	22p
LD87A	22p
LD242	75p
LD271	40p
LD461	25p
LD466	1.45
LD468	1.65
LD471	27p
LD476	1.20
LD478	1.45
LD479	1.65
LD481	27p
LD486	1.25
LD488	1.70
LD489	1.89
LD599	81p
ORP12	1.20
RPY60	2.65
RPY63	2.65
TIL32	71p
TIL63	1.95
TIL64	1.95
TIL65	2.25
TIL66	2.30
TIL67	2.35
TIL78	60p
TIL81	1.60
TIL99	1.35
TIL116	1.10
TIL138	2.40
TIL139	2.40
TIL209	15p
TIL211	19p
TIL212	19p
TIL224	32p
TIL228	42p
TIL312	1.65
TIL313	1.65
TIL401	3.50
TIL403	3.80
TIL406	4.10

NEW OPTO DEVICES

inc. Superbright see next column.

POWERFET AMP MODULES FROM PANTECHNIC
now available from LONDON. Send s.a.e. for specs.

PFA 100	16.00
PFA 200	22.55
10,000 mF 80 V	4.10

D. CONNECTORS 25 WAY

Solder type	
Male	1.60
Fmale	2.05
Angled PCB	
Male	2.45
Fmale	2.90
Covers	99p

NEW OPTO DEVICES
New LEDs
Now in stock
R = red
G = green
Y = yellow

Small diffused		
R2D	8p	6p
G2D	12p	10p
Y2D	12p	10p
Micro 0.1"		
R1D	25p	22p
G1D	27p	25p
Y1D	27p	25p
Large clear		
R5C	12p	10p
G5C	17p	13p
Y5C	17p	13p
Super bright Large (100 times brighter)		
R5U	38p	29p
G5U	42p	34p
Y5U	42p	34p
Tri-colour flat		
RGY8	83p	78p
Large diffused	1+	50+
R5D	9p	7p
G5D	15p	12p
Y5D	15p	12p

LINEAR ICs

AY1-5050	95p
AY3-8910	5.39
AY3-8912	5.59
AY5-2376	5.89
CA3000	4.80
CA3001	4.95
CA3002	4.60
CA3005	3.15
CA3007	4.92
CA3010	1.30
CA3012	1.75
CA3013	4.12
CA3014	2.35
CA3015	2.62
CA3018	75p
CA3018A	2.00
CA3020	2.00
CA3020A	3.90
CA3021	3.20
CA3022	3.12
CA3026	1.52
CA2028A	1.21
CA3028B	2.53
CA3029	1.44
CA3030A	2.97
CA3033	5.44
CA3034	5.18
CA3036	2.75
CA3039	1.50
CA3041	3.47
CA3042	3.47
CA3043	3.92
CA3046	69p
CA3047	4.60
CA3048	2.99
CA3049	3.21
CA3050	4.11
CA3051	3.80
CA3052	2.92
CA3053	1.00
CA3054	1.66
CA3059	2.80
CA3060	4.09
CA3062	13.84
CA3065E	4.62
CA3068	4.23
CA3070	3.20
CA3071	3.30
CA3075	2.25
CA3076	3.42
CA3078T	2.25
CA3080	1.89
CA3080A	3.95
CA3080E	70p
CA3081	1.90
CA3085	1.35
CA3086	55p
CA3089E	1.95
CA3090AQ	3.70
CA3130E	87p
CA3130T	1.80
CA3140E	39p
CA3140T	85p
HA1366W	2.40
HA1388	2.54
ICL7106	7.40
ICL7107	9.50
IOL8038	2.99
ICM7555	80p
LC7120	3.20
LC7130	3.20
LC7137	4.00
LF347	1.50
LF351	47p
LF353	92p
LF355	83p
LF356	92p
LF357	1.09
LF13201	2.99
LF13331	3.30
LF13741H	68p
LF13741N	59p
LM10CH	4.25
LM11CH	4.50
LM114	6.75
LM137K	11.52
LM301AH	1.00
LM301AN	25p
LM305AH	2.90
LM305H	88p
LM307H	1.05
LM307N	55p
LM308AH	3.15
LM308AN	2.14
LM308H	95p
LM308N	88p
LM309K	2.80
LM310H	1.95
LM310N	1.89
LM311H	1.04
LM311N	70p
LM317K	2.80
LM317MP	1.04
LM318H	2.40
LM318N	1.49
LM319H	2.48
LM319N	2.10
LM320 – See 79XX Series Volt Regulators	
LM324N	29p
LM337K	4.75
LM337MP	1.65
LM337T	1.99
LM339AN	1.60
LM339N	47p
LM340 – See 78XX Series Volt Regulators	
LM345K	3.60
LM348N	62p
LM349N	1.16
LM350K	4.60
LM359N	1.44
LM360N	3.88
LM376N	65p
LM377N	1.69
LM378N	3.40
LM379S	4.70
LM380N14	75p
LM380N8	1.50

LM381AN	2.26
LM381N	1.40
LM382N	1.12
LM383T	3.40
LM384N	1.40
LM386N1	88p
LM386N4	1.20
LM388N	2.43
LM391N60	1.70
LM391N80	1.93
LM392N	76p
LM393N	96p
LM394H	3.80
LM396K	13.52
LM709N8	64p
LM709CH	1.00
LM710CH	89p
LM710CN	52p
LM711CH	1.38
LM711CN	70p
LM723CH	1.21
LM723CN	40p
LM725CH	3.40
LM725CN	3.19
LM733CN	69p
LM741CH	96p
LM741CN	15p
LM741CN14	80p
LM747CN	69p
LM748CH	1.00
LM748CN	35p
LM1303N	1.20
LM1304N	2.50
LM1305N	3.10
LM1307N	2.75
LM1310N	1.45
LM1330N	2.25
LM1458	44p
LM1496	1.08
LM1800	3.24
LM1801	2.99
LM1812	8.00
LM1818	2.99
LM1820	2.15
LM1828	4.79
LM1830	2.44
LM1845	4.12
LM1848	2.89
LM1850	2.75
LM1871	4.39
LM1872	4.39
LM1886	7.44
LM1889	3.77
LM2907N	2.75
LM2907NB	2.60
LM2917N	1.89
LM2917N8	1.89
LM3524	6.77
LM3301	1.60
LM3302	74p
LM3401	65p
LM3404	75p
LM3405	1.45
LM3900	48p
LM3905	1.25
LM3909	79p
LM3911	1.20
LM3914	1.79
LM3915	1.99
LM3916	2.19
LM4250CH	2.63
LM4250N	2.39
LM13600	1.09
MB3712	1.99
MB3756	3.80
MB8719	7.95
M53200	8.54
MC1303= LM1303N	
MC1304= LM1304N	
MC1305= LM1305N	
MC1307= LM1307N	
MC1310= LM13010N	
MC1330= LM1330N	
MC1352	1.75
MC1456	1.80
MC1458= LM1458	
MC1466L	6.77
MC1495L	3.75
MC1496= LM1496	
MC3340	1.45
MC3401= LM3401	
MC3403= LM3403	
MC3405= LM3405	
NE531N	1.36
NE540L	4.95
NE543N	2.50
NE544N	1.80
NE555	16p
NE556	45p
NE558	1.89
NE560	3.25
NE565	1.18
NE566	1.49
NE567	1.37
NE570	3.75
NE571	3.75
NE5534	1.49
OM335	7.20
PLL02A	4.95
PLL03A	12.75
RC4136	59p
RC4194	3.95
RC4195	2.95
S556B	2.59
SAD1024A	8.49
SAS560	2.59
SAS570	2.59
SAS580	2.95
SAS590	2.95
SFF96364	7.99
SL470	3.47
SL490	3.47
SL610C	4.00
SL611C	4.00
SL612C	4.00
SL620C	6.00
SL621C	6.00
SL623C	10.00
SL630C	6.00
SL640C	6.00
SL641C	6.00
SN76001N	2.80
SN76008	3.90
SN76018	3.90
SN76003N	2.95
SN76013N	2.95
SN7023N= SN76033N	
SN76033N	2.95
SN76110	2.25
SN76115	2.65
SN76116	2.75
SN76226	3.45
SN76228	2.90
SN76477	4.49
SN76530	1.80
SN76550	80p
SN76666	2.90
SO41P	1.60

SO42P	1.60
TA7210	1.49
TA7204	1.95
TA7205	89p
TA7222	1.45
TA7310	1.49
TAA263	1.50
TAA300	3.95
TAA320	2.05
TAA350	3.60
TAA521	1.50
TAA522	2.47
TAA550	73p
TAA560	2.35
TAA570	2.35
TAA621AX1	2.75
TAA661A	1.50
TAA661B	1.70
TAA700	2.60
TAA930	2.50
TAA930B	2.63
TAA970	2.45
TAA991D	2.45
TAD100	2.00
TBA120AS	69p
TBA331	1.50
TBA341	2.05
TBA395	1.65
TBA396	1.50
TBA450	1.95
TBA460	1.53
TBA500	2.97
TBA500Q	3.11
TBA510	2.95
TBA510Q	3.05
TBA520	2.57
TBA520Q	2.75
TBA530	2.55
TBA530Q	2.76
TBA540	2.72
TBA540Q	2.74
TBA550	3.25
TBA550Q	3.27
TBA560C	2.87
TBA570	2.37
TBA570Q	2.48
TBA581	3.11
TBA641	3.00
TBA651	1.90
TBA673	4.15
TBA700	2.38
TBA700Q	2.47
TBA720AQ	2.60
TBA750	2.25
TBA750Q	2.46
TBA790A	2.11
TBA800	78p
TBA810	95p
TBA820	75p
TBA820M	75p
TBA920	1.95
TBA920Q	1.97
TBA950	2.25
TBA990	2.65
TBA990Q	2.74
TCA105	3.00
TCA160C	2.67
TCA220	3.44
TCA270	2.44
TCA440	2.20
TCA450	2.65
TCA640	4.15
TCA650	4.15
TCA660B	4.15
TCA730	4.80
TCA740	4.80
TCA750	4.85
TCA760	2.75
TCA800	3.50
TBA800Q	3.60
TCA830S	1.90
TCA910	2.19
TCA940	1.69
TDA1002	3.39
TDA1003	3.94
TDA1004	3.94
TDA1005	3.94
TDA1010A	1.79
TDA1022	4.95
TDA1024	1.19
TDA1034	3.20
TDA2020	2.99
TDA2030	2.85
TDA2522	4.20
TDA2530	3.30
TDA2540	4.10
TDA2541	4.10
TDA2560	4.10
TDA2571	4.40
TDA2581	3.75
TDA2590	5.20
TDA2591	4.73
TDA2600	6.15
TDA2610	3.90
TDA2611A	2.50
TDA2640	3.64
TDA3000	2.76
TL061	40p
TL062	60p
TL064	99p
TL071	36p
TL072	50p
TL074	1.30
TL081	50p
TL082	75p
TL083	85p
TL084	89p
TL170	49p
TL430	69p
UAA170	1.69
UAA180	1.69
ULN2003	85p
UPC575C2	2.65
UPC1156	2.75
XR2206	2.92
ZN414	79p
ZN419	2.25
ZN1034	1.99
ZN1040	6.69
ZTK22	89p
ZTK33	89p

TTL

7400	10½p
7401	11p
7402	11p
7403	12p
7404	12p
7405	15p
7406	20p
7407	20p
7408	14p
7409	14p
7410	14p
7411	16p
7412	18p
7413	18p
7414	25p
7416	20p
7417	20p
7420	15p
7421	20p
7422	20p
7423	20p
7425	24p
7426	28p
7427	22p
7428	26p
7430	14p
7432	22p
7433	22p
7437	25p
7438	25p
7440	15p
7441	65p
7442	32p
7443	90p
7444	90p
7445	50p
7446	60p
7447	40p
7448	44p
7450	15p
7451	15p
7453	15p
7454	14p
7460	15p
7470	34p
7472	25p
7473	25p
7474	20p
7475	25p
7476	28p
7480	49p
7481	1.19
7482	68p
7483	38p
7484	69p
7485	60p
7486	20p
7489	2.20
7490	20p
7491	35p
7492	25p
7493	25p
7494	36p
7495	36p
7496	40p
7497	90p
74100	80p
74104	50p
74105	55p
74107	22p
74109	25p
74110	35p
74116	50p
74118	59p
74119	80p
74120	59p
74121	25p
74122	40p
74123	40p
74125	35p
74126	34p
74128	36p
74132	29p
74136	30p
74141	55p
74142	1.99
74143	2.48
74144	2.10
74145	50p
74147	89p
74148	70p
74150	49p
74151	40p
74153	40p
74154	49p
74155	40p
74156	40p
74157	30p
74159	75p
74160	60p
74161	48p
74162	48p
74163	48p
74164	48p
74165	48p
74166	48p
74170	1.25
74172	2.75
74173	60p
74174	59p
74175	49p
74176	39p
74177	45p
74178	79p
74180	40p
74181	1.15
74182	60p
74184	90p
74185	90p
74186	4.69
74188	2.50
74190	48p
74191	48p
74192	45p
74193	45p
74194	45p
74195	46p
74196	45p
74197	48p
74198	83p
74199	83p
74221	53p

74LS TTL

74LS00	11p
74LS01	11p
74LS02	11p
74LS03	12p
74LS04	12p
74LS05	12p
74LS08	12p
74LS10	12p
74LS11	12p
74LS12	12p
74LS13	19p
74LS14	30p
74LS15	12p
74LS20	12p
74LS21	12p
74LS22	12p
64LS27	12p
74LS28	14p
74LS30	12p
74LS32	13p
74LS33	14p
74LS37	14p
74LS38	15p
74LS40	13p
74LS42	28p
74LS47	35p
74LS51	14p
74LS54	14p
74LS55	14p
74LS73	18p
74LS74	18p
74LS75	20p
74LS76	20p
74LS78	18p
74LS80	1.20
74LS83	36p
74LS85	48p
74LS86	16p
74LS90	24p
74LS92	25p
74LS93	24p
74LS95	39p
74LS96	96p
74LS107	20p
74LS109	27p
74LS112	22p
74LS113	22p
74LS114	22p
74LS122	36p
74LS123	36p
74LS124	89p
74LS125	24p
74LS126	25p
74LS132	39p
74LS136	29p
74LS138	32p
74LS139	30p
74LS145	70p
74LS147	1.57
74LS148	75p
74LS151	39p
74LS153	39p
74LS154	79p
74LS155	29p
74LS156	36p
74LS157	27p
74LS158	29p
74LS160	35p
74LS161	35p
74LS162	35p
74LS163	35p
74LS164	40p
74LS165	59p
74LS168	84p
74LS169	85p
74LS170	70p
74LS173	55p
74LS174	45p
74LS175	39p
74LS181	99p
74LS183	1.79
74LS190	36p
74LS191	36p
74LS192	36p
74LS193	37p
74LS194	32p
74LS195	32p
74LS196	45p
74LS197	48p
74LS221	50p
74LS240	55p
74LS241	55p
74LS242	55p
74LS243	55p
74LS244	60p
74LS245	70p
74LS247	50p
74LS248	55p
74LS249	55p
74LS251	30p
74LS253	32p
74LS257	35p
74LS258	35p
74LS259	55p
74LS261	1.35
74LS266	18p
74LS273	60p
74LS275	2.25
74LS279	30p
74LS280	1.60
74LS283	40p
74LS289	4.70
74LS290	45p
74LS293	40p
74LS295	89p
74LS298	89p
74LS299	2.50
74LS323	1.76
74LS324	1.45
74LS325	2.96
74LS326	2.39
74LS327	2.39
74LS347	95p
74LS348	1.00
74LS352	79p
74LS353	79p
74LS362	7.25
74LS365	29p
74LS366	29p
74LS367	29p
74LS368	29p
74LS373	59p
74LS378	58p
74LS386	1.14
74LS390	46p
74LS393	42p
74LS395	89p
74LS396	1.90
74LS398	2.70
74LS399	1.59
74LS445	99p
74LS490	2.20
74LS540	77p
74LS541	99p
74LS640	1.60
74LS641	1.69
74LS643	2.25
74LS644	2.75
74LS669	1.20
74LS670	1.40
74LS673	5.50
74LS674	9.99
74LS688	1.19

74S TTL

74S00	30p
74S02	32p
74S04	32p
74S08	75p
74S20	60p
74S30	60p
74S32	70p
74S40	1.45
74S64	1.02
74S65	1.02
74S74	75p
74S85	2.99
74S86	1.75
74S112	90p
74S113	90p
74S124	2.95
74S132	1.09
74S133	60p
74S138	1.25
74S139	1.49
74S140	2.50
74S153	7.95
74S157	2.75
74S163	3.00
74S174	2.50
74S175	3.20
74S188	3.50
74S189	3.50
74S194	3.50
74S200	4.50
74S201	4.00
74S225	5.25
74S261	3.00
74S262	8.50
74S287	2.99
74S288	1.99
74S289	1.57
74S301	3.20
74S470	3.25
74S471	6.25
74S473	12.50
74S474	3.99
74S475	8.25
74S571	9.00
74S573	9.00

74H TTL

74H00	1.45
74H01	1.45
74H04	1.55
74H05	1.55
74H10	1.45
74H11	1.45
74H20	1.45
74H21	1.45
74H30	1.45
74H40	1.55
74H51	1.75
74H53	1.65
74H54	1.45
74H55	1.40
74H60	1.70
74H62	1.75

74L TTL

74L02	1.00
74L10	1.70
74L47	3.27
74L74	1.20
74L85	4.20
74L86	1.50
74L93	2.30
74L98	2.99

74 CMOS/TTL

74C00	27p
74C04	29p
74C10	28p
74C14	89p
74C20	28p
74C30	36p
74C42	96p
74C48	1.40
74C73	54p
74C76	57p
74C83	1.74
74C85	1.34
74C86	1.10
74C89	5.95
74C90	1.05
74C93	1.44
74C95	1.00
74C107	60p
74C151	2.55
74C154	4.95
74C157	2.20
74C160	1.54
74C161	1.15
74C162	1.16
74C163	65p
74C164	1.15
74C165	2.00
74C173	98p
74C174	65p
74C175	75p
74C192	89p
74C193	68p
74C194	89p
74C195	70p
74C200	10.00
74C221	1.20
74C901	1.91
74C902	71p
74C903	2.30
74C904	1.84
74C905	10.88
74C907	1.91
74C908	1.87
74C911	9.59
74C912	8.00
74C914	2.88
74C915	1.99
74C918	2.50
74C920D	8.50
74C922	4.50
74C923	5.00
74C925	6.00
74C926	6.58
74C928	6.00
74C929	5.20
74C930J	7.80
74C932	3.12

40 CMOS

4000	10p
4001	10p
4002	11p
4006	49p
4007	15p
4008	32p
4009	24p
4010	10p
4011	10p
4012	15p
4013	20p
4014	46p
4015	58p
4016	20p
4017	32p
4018	45p
4019	26p
4020	44p
4021	39p
4022	48p
4023	12p
4024	32p
4025	12p
4026	79p
4027	20p
4028	29p
4029	29p
4030	14p
4031	1.19
4032	80p
4033	1.20
4035	1.29
4035	59p
4036	2.49
4037	1.30
4038	99p
4039	2.80
4040	46p
4041	40p
4042	39p
4043	46p
4044	41p
4045	99p
4046	44p
4047	39p
4048	39p
4049	22p
4050	23p
4051	44p
4052	49p
4053	49p
4054	79p
4055	83p
4056	89p
4059	4.35
4060	42p
4063	79p
4066	22p
4067	2.49
4068	14p
4069	13p
4070	13p
4071	13p
4072	13p
4073	13p
4075	13p
4076	45p
4077	13p
4078	13p
4081	12p
4082	12p
4085	49p
4086	53p
4089	1.50
4093	20p
4094	69p
4095	66p
4096	90p
4097	2.88
4098	74p
4099	90p

For higher numbers in 40 Series, substitute 74C for 40 prefix. eg 40107 = 74C107

45 CMOS

4502	59p
4503	29p
4507	33p
4508	1.19
4510	35p
4511	48p
4512	39p
4514	1.17
4515	1.17
4516	59p
4518	39p
4519	29p
4520	48p
4521	99p
4526	59p
4527	59p
4528	46p
4532	69p
4534	4.29
4536	2.59
4538	65p
4539	99p
4543	56p
4553	2.25
4555	35p
4556	35p
4560	1.49
4566	1.49
4569	1.59
4584	39p
4585	79p

COMPUTER ICs
CPUs

1802	7.00
2650A	11.99
6502	3.24
6800	2.74
6802	2.69
6809	8.50
8035	3.49
8060	10.90
8080A	2.79
8085A	3.49
8900	57.75
9980	21.00
SCMP1	17.66
Z80A	3.50

MEMORIES

2101	4.00
2102AL2	1.35
2111-1	3.00
2114(200ns)	85p
2532	3.60
2564	11.95
2708	2.25
2716 (5v)	2.11
2764	9.75
4027	3.00
4044	7.00
4060	9.50
4116(200ns)	75p
4118-3	3.25
4164	4.50
5204	7.50
6116	4.40
6514	3.30
6810	1.15
7489	4.20
74189	4.00
74LS289	3.25
74LS188	2.25
74LS287	3.05
74LS288	2.25

ZERO INSERTION DIL SOCKETS

24pin	4.90
40pin	5.30

LOGIC ICs inc.COMP. SUPPORT

ADC0804	3.95
ADC0816	14.90
ADC0817	10.06
AY5-1013A	3.00
AY5-2376	5.90
ICM7555	80p
INS1671	20.00
INS1771	20.00
INS1792	30.00
MC1466L	6.50
MC1488	55p
MC1489	55p
MC4024	3.25
MC4044	3.25
MK50250	10.00
MK50398	6.95
MM5303	6.25
MM5307	12.75
MM5357	22.50
MM57105	14.00
MM57109	12.00
MM57160	9.00
MM57161	9.00
MM58174	11.80
RO2513LC	6.99
RO2513UC	7.50
SAA5000	3.00
SAA5010	7.10
SAA5012	7.10
SAA5020	5.50
SAA5030	9.00
SAA5040	15.00
SAA5041	15.00
SAA5050	8.50
SAA5052	8.50
TMS6011	3.65
ULB2003A	85p
8T26	1.35
8T28	1.35
8T95	1.35
8T97	1.35
81LS95	90p
81LS96	1.20
81LS97	90p
81LS98	1.20
6522	3.19
6532	6.95
6821	1.12
6845	10.00
6847	10.00
6850	1.35
6852	2.40
6875	4.85
8131	3.75
8154	9.42
8155	3.50
8212	1.10
8216	1.00
8223	1.80
8224	2.10
8226	2.50
8228	2.50
8238	5.75
8243	4.68
8250	8.65
8251	3.15
8253	7.95
8254	10.00
8255	2.48
8257	4.00
8259	4.00
8279	4.40
8304	4.50
8544	1.50
8601	1.20
8678CABN	19.50
8832	2.60
8833	2.35
9097	3.00
9099	3.00
9601	5.50
9062	2.50
Z80ACTC	2.65
Z80ADART	8.00
Z80ADMA	10.00
Z80APIO	2.80
ZN425E8	3.39
ZN426E8	3.39
ZN427E8	5.99
ZN428E8	4.05

VOLTAGE REGULATORS
(See also Linear ICs)
– Positive –

100 mA	
78L05A	30p
78L12A	30p
78L15A	30p
78L24A	30p
100 mA TO5	
78L05CH	80p
78L12CH	80p
78L15CH	80p
78L24CH	80p
500 mA TO202	
7805M	47p
7812M	47p
7815M	47p
7842M	47p
1 Amp TO220	
7805T	39p
7812T	39p
7815T	39p
7824T	39p
1.5 Amp TO03	
7805K	1.39
7812K	1.39
7815K	1.39
7824K	1.39

– Negative –

100 mA TO92	
79L05	59p
79L12	59p
79L15	59p
500 mA TO202	
7905M	55p
7912M	55p
7915M	55p
7924M	55p
1 Amp. TO220	
7905T	44p
7912T	44p
7915T	44p
7924T	44p
1.5 Amp. TO3	
7905K	1.99
7912K	1.99
7915K	1.99
7924K	1.99

– Variable –

L200 (2A Pos)	2.50
LM137K	12.00
LM309K	1.35
LM317K	3.42
LM317MP	95p
LM317T	1.75
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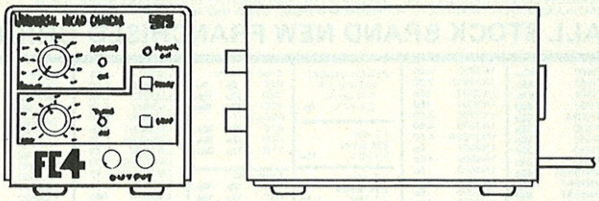

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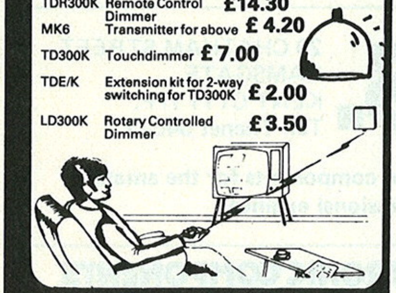

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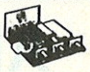

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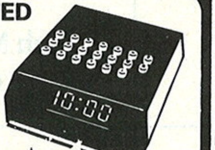

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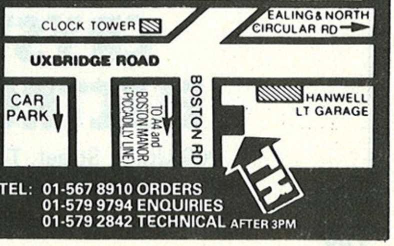

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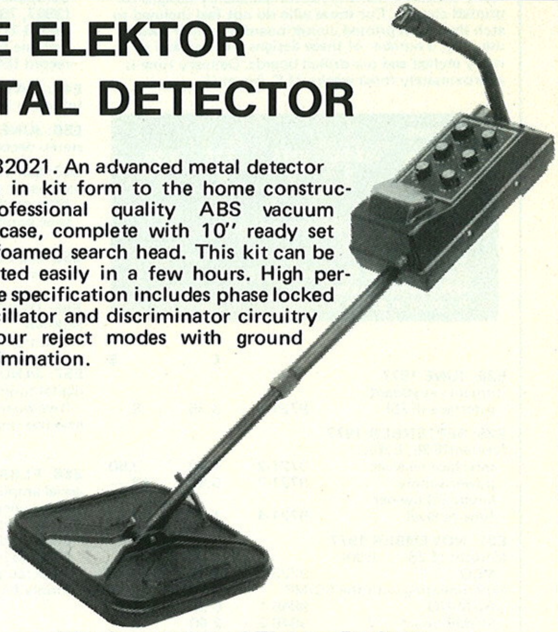

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eps-service

Many Elektor circuits are accompanied by designs for printed circuits. For those who do not feel inclined to etch their own printed circuit board, for their own use only, a number of these designs are available as ready etched and pre-drilled boards. Delivery time is approximately three weeks, U.K./air mail.

Example:

digisplay	(E13)	9376	3.25	7.25
1	2	3	4	5

1. Circuit title
2. reference to associated article(s)
3. board number

U.K.:

4. price (in £) inclusive of 15% VAT

U.S.A. and Canada:

5. price in $, not including tax (if any)

		£	$
E26: JUNE 1977			
formant: keyboard interface (E25)	9721-1	3.35	8.—
E29: SEPTEMBER 1977			
formant(E25, E26):			
interface receiver	9721-2	1.40	3.50
power supply	9721-3	5.50	13.—
keyboard divider (one octave)	9721-4	1.30	3.—
E31: NOVEMBER 1977			
formant (E25 . . . E30):			
VCO	9723-1	9.90	23.50
experimenting with the SC/MP:			
RAM-I/O	9846-1	6.90	16.50
SC/MP board	9846-2	2.60	6.—
E32: DECEMBER 1977			
formant (E25 . . . E31):			
VCF	9724-1	4.35	10.50
experimenting with the SC/MP (E31): CPU	9851a	12.90	31.—
E33: JANUARY 1978			
simple function generator	9453	3.25	8.—
formant (E25 . . . E32):			
ADSR	9725-1	4.20	10.—
UAA 180 LED voltmeter (two boards)	9817	2.70	6.50
experimenting with the SC/MP (E31, E32):			
bus board (E57)	9857	4.—	9.50
memory card	9863	12.60	30.—
E34: FEBRUARY 1978			
formant (E25 . . . E33):			
DUAL-VCA	9726-1	4.35	10.50
experimenting with the SC/MP (E31 . . . E33):			
HEX-I/O	9893	18.20	43.50
E35: MARCH 1978			
formant (E25 . . . E34):			
LFO module	9727-1	4.50	11.—
noise module	9728-1	4.—	9.50
4 k RAM card	9885	14.70	35.—
E36: APRIL 1978			
formant (E25 . . . E35):			
COM	9729-1	4.—	9.50
elektornado	9874	3.55	8.50
cassette interface	9905	3.—	7.—
E38: JUNE 1978			
mini-counter	9927	3.15	7.50
E39/40: SUMMER CIRCUITS 1978			
preconsonant	9954	2.25	5.50
E41: SEPTEMBER 1978			
formant			
24 dB VCF	9953-1	4.10	10.—
E42: OCTOBER 1978			
resonance filter module	9951	4.45	10.50
VHF/UHF modulator	9967	1.55	4.—
E43: NOVEMBER 1978			
ASCII keyboard	9965	7.70	18.50
E44: DECEMBER 1978			
elekterminal	9966	7.50	18.—
E48: APRIL 1979			
TV games computer:			
UHF/VHF modulator (see E42, October 1978)	9967	1.55	4.—
main board and documentation	79073	19.95	47.50
power supply	79073-1	2.45	6.—
keyboard p.c.b.	79073-2	3.65	8.50
Complete set of four boards (9967, 79073, 79073-1, 79073-2), documentation and one ESS software record (ESS 006):		26.25	62.50
E49: MAY 1979			
Interface for μPs	79101	1.40	3.50
E50: JUNE 1979			
stereo decoder	79082	2.40	5.50
E53: SEPTEMBER 1979			
parametric equaliser,			
filter section	9897-1	1.65	4.—
tone control section	9897-2	1.65	4.—
E55: NOVEMBER 1979			
topamp	80023	1.45	3.50
E56: DECEMBER 1979			
SEWAR	80009	2.85	7.—
steam train	80019	1.90	4.50
E57: JANUARY 1980			
digital tuning scale (two boards)	80021-1/2	7.05	17.—
new bus board (E33)	80024	5.85	14.—
E58: FEBRUARY 1980			
aerial amplifier	80022	1.85	4.50
elektor vocoder,			
bus board 1	80068-1	9.90	23.50
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filter board	80068-3	3.45	8.—
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supply board	80068-5	2.85	7.—
E59: MARCH 1980			
chorosynth	80060	22.15	53.—
E60: APRIL 1980			
aide-de-camp: 12 V/2 A	7043B	1.10	2.50
transistor ignition	80084	3.90	9.50
E61: MAY 1980			
BASIC cassette interface	80050	5.60	13.50
PWM amplifier	80085	1.50	3.50
Junior computer:			
main board	80089-1	12.60	30.—
display board	80089-2	1.30	3.—
supply board	80089-3	3.—	7.—
E63/64: SUMMER CIRCUITS 1980			
STAMP amplifier	80543	1.40	3.50
PROM programmer	80556	3.85	9.—
E65: SEPTEMBER 1980			
8K RAM + EPROM card	80120	13.15	31.50
E67: NOVEMBER 1980			
central heating pump control	81019	2.55	6.—
fridge alarm	81024	1.45	3.50
E69: JANUARY 1981			
big VU meter			
low voltage board	81085-1	2.30	5.50
main board	81085-2	2.45	6.—
E70: FEBRUARY 1981			
voiced/unvoiced detector			
detector board	81027-1	3.40	8.—
switch board	81027-2	4.05	9.50
E71: MARCH 1981			
MW receiver	81111	1.95	4.50
multiple sound effects generator	81112	2.05	5.—
High Com:			
2 complete modules (built and tested) + 1 main board + self-adhesive front panel	81117-1	35.70	85.—
power supply	81117-2	2.05	5.—
UAA LED voltmeter (2 boards)	9817	2.70	6.50
peak programme meter	9860	2.—	5.—
E72: APRIL 1981			
transistor match-maker	81123	1.75	4.—
intelekt	81124	5.65	13.50
universal power supply	81128	2.45	6.—
E74: JUNE 1981			
Junior Computer			
interface board	81033-1	19.05	45.50
−12 V supply	81033-2	1.45	3.50
adaptor board	81033-3	1.30	3.—
storage scope	81141	3.80	9.—
E75/76: SUMMER CIRCUITS 1981			
continuity tester	81151	1.25	3.—
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hi-fi preamplifier	81570	4.35	10.50
input buffers for the logic analyser	81577	2.—	5.—
E77: SEPTEMBER 1981			
TV games computer			
extension board	81143	19.—	45.—
disco light controller	81155	3.20	7.50
DFM + DVM	81156	4.25	10.—
revolution counter	81171	4.90	11.50
digital barometer	81173	3.50	8.50
E78: OCTOBER 1981			
RF-test generator	81150	1.60	3.80
economical fridge defroster	81158	1.80	4.35
EPROM programmer	81594	1.45	3.50
wide range dark room timer	82004	2.25	5.50
shutter speed meter	82005	3.75	9.—
LCD panel meter	82011	1.65	4.—
E79: NOVEMBER 1981			
teletext			
decoder board	82001-2	5.35	12.50
keyboard section	82001-3	3.15	7.50
sine-wave oscillator	82006	2.10	5.—
telephone amplifier	82009	1.55	3.50
power supply	9968-5A	1.40	3.50
mini organ	82020	3.50	8.50
metal detector	82021	5.65	13.50
LCD frequency counter	82026	2.—	5.—
high boost	82029	1.85	4.50
E80: DECEMBER 1981			
70 cm transverter (Oct.)	80133	12.50	30.—
teletext			
receiver board	82001-1	4.10	10.—
video control board	82001-4	4.25	10.—
VHF-UHF converter board	9864	1.75	4.—
IPROM	82019	1.65	4.—
synthesizer VCO	82027	4.40	10.50
flashing light	82038	1.60	4.—
capacitance meter module	82040	2.—	5.—
E81: JANUARY 1982			
EPROM programmer	82010	4.65	11.—
synthesiser VCF + VCA	82031	4.25	10.—
E82: FEBRUARY 1982			
synthesiser ADSR	82032	4.20	10.—
synthesiser LFO	82033	3.90	9.50
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E83: MARCH 1982			
wind sound generator	82066	1.60	4.—
automatic squelch	82077	1.90	4.50
synthesiser COM	9729-1	4.—	9.50
synthesiser power supply	82078	3.70	9.—
bus board	82079	3.35	8.—
DNR noise reduction	82080	2.85	7.—
lead acid charger	82081	1.95	4.50
E84: APRIL 1982			
dynamic RAM card	82017	4.90	11.50
100 W amplifier	82089-1	2.60	6.—
100 W power supply	82089-2	2.40	5.50
2114 RAM tester	82090	1.90	4.50
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E85: MAY 1982

6502 housekeeper			
main board	81170-1	4.05	9.50
display board	81170-2	3.05	7.50
elektor artist	82014	10.05	24.—
Z80-A CPU card	82105	7.05	17.—
polyformant:			
debounce unit	82106	2.45	6.—
input unit	82107	4.65	11.—
tune shift	82108	2.75	6.50
prop-tachometer	82116	2.10	5.—

E86: JUNE 1982

the 'Poly bus'	82110	3.35	8.—
talking clock	82121	3.15	7.50
compact shortwave SSB receiver	82122	5.—	12.—
fluorescent tube dimmer	82128	1.60	4.—
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electronic fluorescent light starter	82138	1.35	3.—

E87/88: SUMMER CIRCUITS 1982

polyformant:			
output unit	82111	4.70	11.—
D/A converter	82112	1.90	4.50
stereo power amplifier	82527	1.60	4.—
light-sensitive switch	82528	1.60	4.—
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sound effects generator	82543	2.40	5.50
slave flash	82549	1.45	3.50
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E89: SEPTEMBER 1982

rugby MSF receiver	80524	5.80	15.—
darkroom computer part I			
keyboard	82141-1	3.75	9.—
keyboard interface	82141-2	2.—	5.—
display	82141-3	2.25	5.50
gas detector	82146	1.60	4.—
house telephone system:			
main board	82147-1	3.—	7.—
power supply	82147-2	1.50	3.50
three phase tester	82577	2.70	6.50
TV games:			
'rapid loader'	82558-1	3.45	8.—
EPROM plug-in board	82558-2	1.95	4.50

E90: OCTOBER 1982

darkroom computer part II			
light meter	82142-1	1.75	4.—
temperature meter	82142-2	1.60	4.—
process timer	82142-3	2.—	5.—
active antenna:			
R.F. board	82144-1	1.55	3.50
power supply	82144-2	1.55	3.50
digital thermometer	82156	2.15	5.—
wave shifter for SSB:			
low frequency converter	82161-1	2.05	5.—
high frequency converter	82161-2	2.30	5.50

E91: NOVEMBER 1982

model train lighting	82157	4.05	9.50
floppy disk controller	82159	4.70	11.—
talking dice	82160	3.—	7.—
guitar tuner	82167	2.20	5.—
cerberus	82172	2.35	5.50

E92: DECEMBER 1982

in-car ioniser			
power supply	82162	1.50	3.50
main board	9823	4.20	10.—
precision power supply	82178	4.05	10.—
triopodus electrus diclopus	82179	2.95	7.—
crescendo	82180	4.60	11.—

E93: JANUARY 1983

3 A computer			
power supply	83002	1.85	4.50
milli-ohmmeter	83006	1.90	4.50
crescendo			
d.c. protection and countdown	83008	3.—	7.—

NEW

E94. FEBRUARY 1983

audio/video modulator	82190	3.25	7.50
fuse protector	83010	1.55	3.50
universal modem	83011	6.30	12.60
Prelude			
headphone amplifier	83022-7	4.25	8.50
power supply	83022-8	3.90	7.80
connection board	83022-9	6.25	12.50

front panels

front panels for Formant (E25 . . . E35)			
interface	9721-F	1.60	4.—
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VCF	9724-F	1.60	4.—
ADSR	9725-F	1.60	4.—
DUAL-VCA	9726-F	1.60	4.—
LFOs	9727-F	1.60	4.—
NOISE	9728-F	1.60	4.—
COM	9729-F	1.60	4.—
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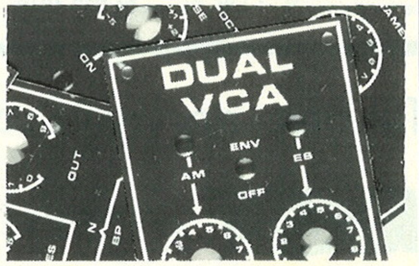
24 dB VCF (E41)	9953-F	1.60	4.—
resonance filter module (E42)	9951-F	1.60	4.—
simple function generator (E33, E38)	9453-F	2.50	6.—
Elektor Artist (E85)	82014-F	1.70	4.—
precision power supply (E92)	82178-F	1.90	4.50



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45 RPM records with μP programs

singing SC/MP: well-known Christmas melodies, both as SC/MP program and 'live'	ESS 002	1.40	3.—
NIBL-E	ESS 004	1.40	3.—
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μP TV games: 15 programs: invaders, fishing, maze adventure, memory, pontoon, nim, etc.	ESS 009	5.50	11.—

μP TV games

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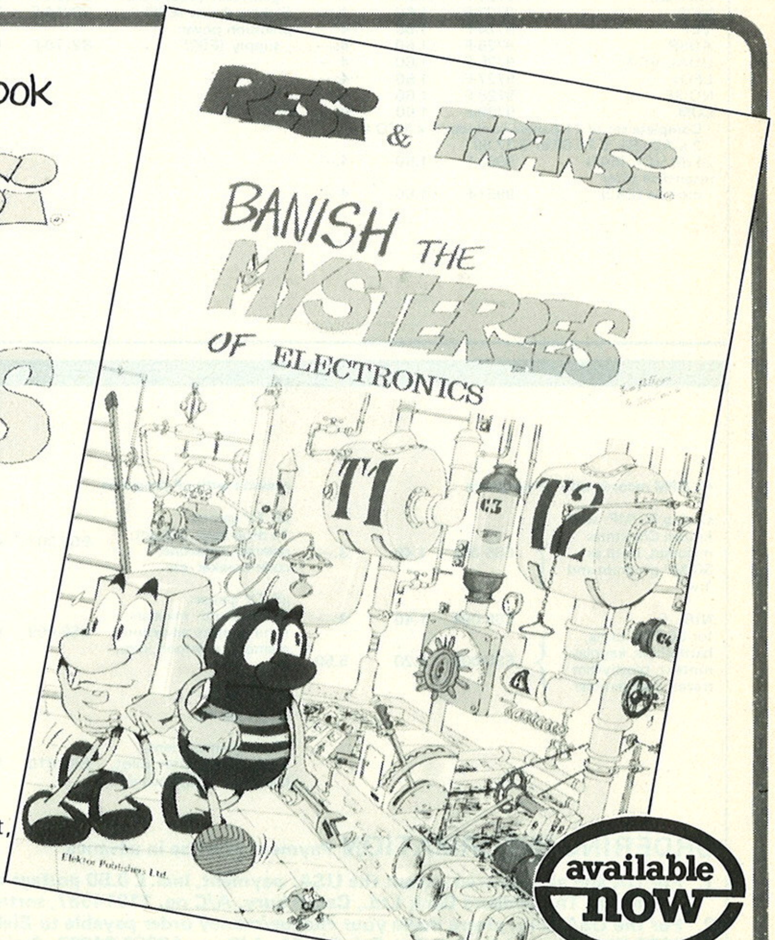

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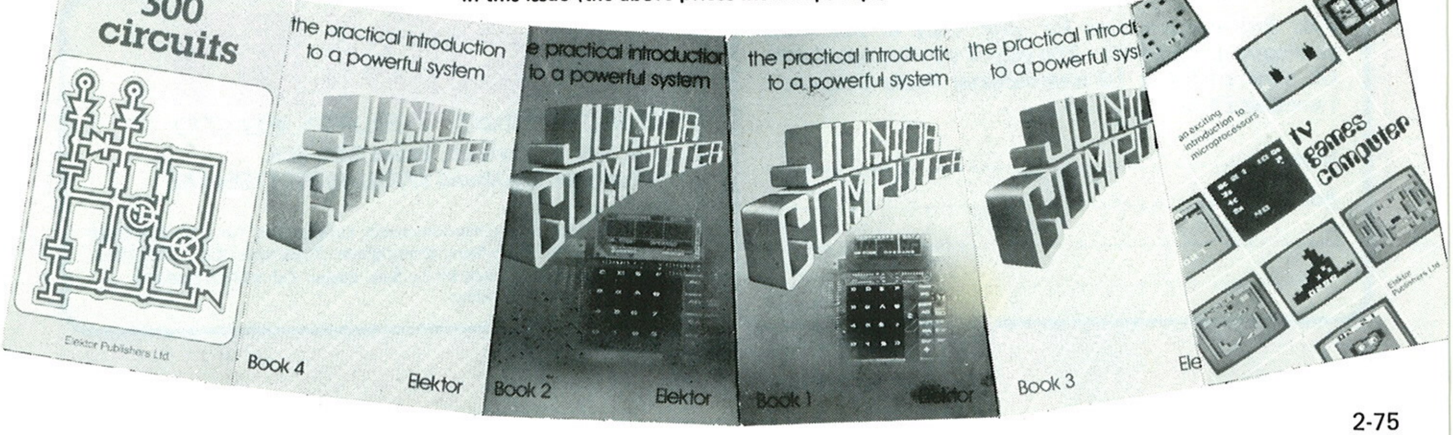

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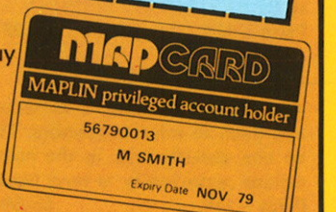

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